

Exhibit 42

**UNITED STATES DISTRICT COURT
DISTRICT OF NEW JERSEY**

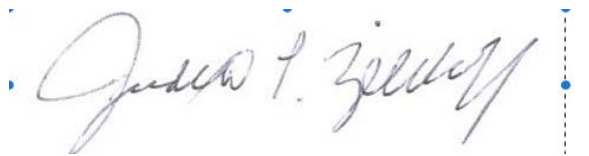
**IN RE JOHNSON & JOHNSON
TALCUM POWDER PRODUCTS
MARKETING, SALES PRACTICES,
AND PRODUCTS LIABILITY
LITIGATION**

MDL NO. 16-2738 (FLW) (LHG)

THIS DOCUMENT RELATES TO ALL CASES

**RULE 26 EXPERT REPORT OF
JUDITH ZELIKOFF, PHD**

Date: November 16, 2018

A handwritten signature in blue ink, reading "Judith T. Zelikoff", is positioned above a horizontal line. The signature is written in a cursive style. To the right of the signature, there is a vertical dashed line with a blue dot at the bottom.

Judith Zelikoff, PhD

I. BACKGROUND AND QUALIFICATIONS

I received my Ph.D in Experimental Pathology and Immunology at Rutgers: NJ Medical School (formerly known as University of Medicine and Dentistry of NJ) in 1982, after receiving a Master's degree from Fairleigh Dickinson University in Microbiology. My post-doctoral training was in toxicology at the NYU School of Medicine, Department of Environmental Medicine as a National Heart Lung Blood Institute (NHLBI) fellow.

I am currently a tenured-professor in Toxicology at NYU. As part of the NYU NIEHS (National Institute of Environmental Health Science) Center of Excellence, I serve as Director of the Community Engagement Core. In this capacity, I engage with environmentally-impacted underserved communities throughout New Jersey and New York to better engage the community to achieve long-term and sustainable outcomes, processes, relationships, discourse, decision-making, and implementation regarding environmental health. These goals are carried out through town hall meetings, focus groups, listening sessions, forums on relevant environmental concerns, surveys, as well as outdoor and indoor measurements of toxic metals such as lead, cadmium, mercury, and arsenic in water, air, and soil. I also provide service to the NYU School of Medicine as a member of the Grievance Committee, Institutional Animal and Use Committee (IACUC) and as an NYU Senator representing the School of Medicine.

I have served in numerous leadership positions in the field of toxicology, including NIH Study Sections, United Nations Environmental Programme, NASA boards, and National Academy of Science Panels (i.e., Institute of Medicine, National Research Council and Engineering, and Medicine's Board on Earth Sciences and Resources), as well as Environmental Protection Agency study sections and advisory boards concerning the toxic effects of air pollution, metals, and alternative tobacco products. Furthermore, I served for two years (2010-2012) as a member of the National Toxicology Program (NTP) Board of Scientific Advisors. In this capacity, I reviewed documents and provided input and guidance on the toxicity of various chemicals that were nominated for review and sent to the NTP for study and/or discussion. In some cases, we also decided on the carcinogenicity of specific compounds. I was not part of the NTP 10 ROC or 12 ROC, both of which deferred the decision on talc.

In addition, I presented about 150 international/national papers in the areas of toxicology and environmental and public health. I have organized several international toxicology meetings, served as editor for several toxicology/environmental public health books and authored numerous book chapters in the same areas. I have over 125 publications and book chapters in the area of immunotoxicology (for which I received a Lifetime Achievement Award from the Society of Toxicology), air pollution toxicology, metal toxicology, immunotoxicology, and developmental and reproductive toxicology associated with inhaled metals, mixtures, nanomaterials, dusts (i.e., World Trade Center Dust), and tobacco/nicotine toxicology.

I have held numerous executive positions in the Society of Toxicology (SOT) which includes three years as Secretary on the SOT Executive Council and one year as Chair of the Education Committee and Committee for Diversity Initiatives Committees. I have also provided leadership for four individual SOT Specialty Sections (SS). I have served as President of the Immunotoxicology, Metals and Ethical, Legal, Forensic and Societal Issues Specialty Section and currently serve as Senior Councilor of the Inhalation and Respiratory Specialty Section. I have received three major SOT awards including the Mentorship Award from “Women in Toxicology”, Global Host award and in 2018, Education award for meritorious teaching skills in toxicology. As a teaching scholar, I have taught and continue to teach toxicology on a global level in such countries as Thailand, Nigeria, South Africa, Tasmania and New Zealand.

My education, training and publications are further set out in my Curriculum Vitae, which is attached to this report as an **Exhibit A**.

II. MANDATE AND METHODOLOGY

Mandate: I was asked to review the scientific literature and assess whether there is a biologically plausible explanation for the increased risk of ovarian cancer with the perineal use of talcum powder products.

The notion of biological plausibility is multi-factoral. As a part of my analysis, while considering the totality of the evidence, I evaluated the genital use of talcum powder products, the routes of exposure by which talcum powder could reach the ovaries, the composition of the talcum powder products, the biological and toxicological effects of talcum powder, and the potential mechanisms of carcinogenesis. Biological plausibility does not mean proof of mechanism, but rather whether what is known about the products is consistent with a cause and effect relationship.

I performed an independent, comprehensive literature review using research databases and search engines including PubMed, ToxLit and Google to identify relevant literature. The keywords/phrases used initially for searching, included: talc, talcum powder, talc and cancer, talc and toxicity, talc and toxicology, ovarian cancer, oxidative stress, talc and ovarian cancer, animal models and talc, talc powder and the immune response and talc chemical structure. Keywords and phrases expanded upon those terms in later searches.

More than 300 publications (research papers, reviews, abstracts, reports, documents) and book chapters from the 1960s to the present were identified as having some relevancy for the talc-ovarian cancer topic. Following closer scrutiny of these publications, between 200-250 research papers, scholarly reviews, abstracts, documents, reports were found critical for informing my opinion. Toxicological studies, including *in vivo*, *in vitro* and *ex vivo* investigations, were the topics most appropriate for my area of expertise. In addition, I have reviewed depositions and numerous documents, internal memorandum

and published and unpublished studies and testing results that I have found in my own searches, documents provided by attorneys, and documents that I requested. A list of materials and data considered for this report are attached as **Exhibit B**.

My opinions below are based upon my experience as a toxicologist and research scientist and have been reached through employing the same scientific methodology and rigor that I employ in my academic research and professional duties. To my knowledge, I considered and evaluated the majority of all available relevant studies in the process of evaluating the literature, including those that reported an elevated risk of ovarian cancer with exposure to talc and those where other chemicals were reported within talc-based body powders, including those that did not find an increased risk. The same approach was used in evaluating the animal data and the mechanistic data.

III. TALC

Primary talc deposits are found on almost every continent around the world¹. Talc is commonly formed by the hydrothermal alteration of magnesium- and iron-rich rocks (ultramafic rocks) and by low-grade thermal metamorphism of siliceous dolomites. Talc is the softest mineral on earth, mined around the world for use in a wide variety of products personal, cosmetic or industrial in nature. The word “talc” can refer to two things. The first is a mineral and the second is a commercially available product that can be used both industrially and in pharmaceuticals and cosmetics. For this report, when talking about the former, I use the term “mineral talc,” and when talking about the latter, I use the term “talcum powder products.” Johnson & Johnson talcum powder products are classified as cosmetic talc. Dermal contact (including perineal application of talcum powder products) is a primary route of human exposure, while inhalation also represents a route of exposure for talc/talcum powder products.

As a mineral, talc corresponds to the chemical structure of hydrous magnesium silicate with a formula of $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ and a theoretical chemical composition, expressed as oxides, of 31.7% by weight magnesium oxide (MgO), 63.5% silicon dioxide (SiO_2) and 4.8% water (H_2O). Talc belongs to the silicate subclass phyllosilicates and is known as a sheet silicate. It is the softest mineral on Mohs’ hardness scale, and its structure and chemical bond arrangement is such that it is easily broken into thin sheets. The structure consists of three sheets that are octahedrally coordinated magnesium hydroxide groups (brucite layer) layered between 2 layers of tetrahedrally linked silica layers. The apical oxygen atom positions of the tetrahedral layers are shared with one of the oxygen atom positions of the octahedral layer. The composite sheets repeat every 9.4 angstroms and the triple-sheet crystalline units are held together by van der Waals forces. Talc particles are normally plate-like in shape, but may form mineral fibers, as discussed below.

¹ <https://minerals.usgs.gov/minerals/pubs/commodity/talc/mcs-2017-talc.pdf>

Small amounts of aluminum and ferric (III) iron can substitute for silicon in talc tetrahedral sites. Trace amounts of nickel and small to moderate amounts of ferrous (II) and ferric (III) iron, aluminum and/or manganese can substitute for magnesium in talc octahedral sites. Additionally, talc deposits may contain varying amounts of quartz, nickel, chromium and cobalt, as well as asbestos or asbestos-forming minerals including amphibole (tremolite, actinolite, antigorite and anthophyllite) and serpentine (chrysotile) (Cralley, 1968; Locky, 1981; McCarthy 2006; Rohl, 1976). The pH of cosmetic talcs are usually alkaline (8.0-9.5) and are insoluble in water, cold acids or in alkalis.

Talc powder particle size depends on the process used to make the powder. Johnson and Johnson's analysis of particle size in talcum powder shows particles range on average from 0.8 μm to over 50 μm , with a median particle size of 11.39 μm , where approximately 43.9% of particles are less than 10 μm (JNJ TALC00878141).

A. Fibrous Talc

As a mineral, talc is most commonly found in plate-like form, but may also form as true mineral fibers that are asbestiform (IARC 2010, IARC 2012). Asbestiform talc (also known as fibrous talc) is different from talc containing asbestos. Fibrous talc fibers are very long and thin and occur in parallel bundles that are easily separated from each other by hand pressure (IARC Monographs, 2010). The 2010 IARC clearly states that the term 'asbestiform fiber' means any mineral, including talc, when it grows into an asbestiform habit. In its fibrous form, talc has been classified as a Group I, known carcinogen (IARC 1987 Supp 7; IARC 2010; IARC 2012). OSHA considered fibrous talc exposure limits to be equivalent to those of asbestos (OSHA, 1972). In 2010, IARC expanded the Group 1 designation ("known carcinogen") from "talc containing asbestiform fibers" to "talc containing asbestos or other asbestiform fibres." (IARC, 2010). Additionally, the American Conference of Governmental Industrial Hygienists (ACGIH) clarifies that "talc may also take the form of long thin fibers (fibrous talc) and can occur in bundles that are easily separated (asbestiform talc). Asbestiform talc should not be confused with talc containing asbestos..." (ACGIH, 2010).

Asbestiform talc fibers have been reported by Johnson & Johnson and Imerys to be found in: mines from which ore for Johnson & Johnson talcum powder products were sourced; in talcum powder used in Johnson & Johnson talcum powder products; and in the Johnson & Johnson talcum powder final product.²

Recent TEM testing on historic samples of Johnson's Baby Powder from 1978 showed the presence of fibrous talc in the product (Longo & Rigler, Feb 2018 MAS Report). Additional TEM testing of 30 samples of J & J baby powder and Shower to Shower dating from a span of many years resulted in a finding of fibrous talc in 15 samples (Longo & Rigler, Aug 2017 Expert Report).

² See also: IMERYS477879 (fibrous talc in Grade 66 Q1 composite); JNJ 000269848 (talc needles found in medicated powder 1971, see with TEM results in JNJ 000281921); JNJ 000245002 (Fibrous talc in Hammondsville mine 1970)) .

IV. ASBESTOS

Asbestos, like talc, is a naturally occurring silicate mineral, but with a different crystal structure (Mossman & Churg, 1998). Asbestos is a generic name referring to a group of naturally occurring mineral silicate fibers. It is recognized as a known human carcinogen by the U.S. Occupational Safety and Health Administration (OSHA), the U.S. Environmental Protection Agency (USEPA) and the National Toxicology Program (NTP)(OSHA, 2014; USEPA, 1995; NTP, 2016). The National Institute for Occupational Health (NIOSH) has stated there is no safe level of asbestos and the American Conference of Governmental Industrial Hygienists (ACGIH) characterizes it as a “confirmed human carcinogen” (NIOSH, 1980; ACGIH, 2017). All forms of asbestos are Group 1 carcinogens (carcinogenic to humans)(IARC, 2012).

The U.S. EPA defines asbestos by limiting the term to 6 specific fibrous minerals from two distinct groups: chrysotile (from the Serpentine group); and amosite, crocidolite, tremolite, actinolite and anthophyllite (from the Amphibole group). “Asbestiform” describes the pattern of growth of a mineral that is referred to as a “habit” (IARC, 2010). Minerals with a “non-asbestiform” habit have crystals that grow in two or three dimensions, and “cleave into fragments, rather than breaking into fibrils” (*Id.*). Chrysotile occurs in the asbestiform habit, whereas, of the amphiboles, amosite and crocidolite occur only in the asbestiform habit, and tremolite, anthophyllite and actinolite can occur in asbestiform or non-asbestiform habits. OSHA defines an asbestos fiber as having a length > 5mm and a length:width aspect ratio of 3:1, whereas the USEPA definition incorporates the aspect ratio of > 5:1 (OSHA, 1992; USEPA, 1987).

While amphibole and serpentine asbestos may have fibrous habits, they have very different forms. The amphiboles are double-chain silicates also called inosilicates. The basic structural unit is $(\text{Si}_4\text{O}_{11})^{6-}$ with side groups that are responsible for the overall amphibole structure. Amphiboles are distinguished from one another by the amount and positioning of metal atoms including: sodium, calcium, manganese, magnesium, iron(II), iron(III) and aluminum. Traces of these types of asbestos are extracted when other minerals are being mined and, due to inefficient or non-existent separation techniques, are ultimately incorporated into the final product. Even incidental contamination by amphibole forms of asbestos is hazardous enough to cause asbestos-related illnesses (Rohl & Langer, 1976).

The serpentine group of minerals has the formula $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ and the structure resembles a bending sheet. Chrysotile is the only one in which the sheets are bent to form continuous tubes, which gives the mineral the fibrous habit related to asbestos. Chrysotile is very flexible and less likely to be “friable” than the amphiboles. Friability of asbestos is generally defined as the ability to easily be turned into a dust with finger pressure. It is this friability that can release asbestos fibers and potentially result in health problems.

A. Asbestos in Talc

Associated minerals found in commercial talc products vary from deposit to deposit depending on the formation conditions. The most common minerals associated with talc include chlorite, magnetite, dolomite, calcite, mica, quartz and fluoapatite (Fiume et al., 2015). In its natural form, some talc also contains asbestos, classified as a Group I, “known carcinogen” by IARC (IARC Monographs, 1973, 1977, 1987, 2012). Amphiboles and serpentine fibers have been associated with many talc deposits (Van Gosen, 2004; Marconi and Verdel, 1990; Lockey, 1981; Rohl and Langer, 1974; Gamble et al., 1979; Kleinfeld et al., 1973, 1974; Pooley, 1972 (JNJ000319762); Chidester, 1968). The close proximity of asbestos and talc in mineral deposits makes extraction of either material alone difficult, if not impossible. (Rohl and Langer, 1974; IARC, 2010; Dion et al. 2010³).

Cralley (1968) analyzed twenty-two commercially available cosmetic talcum products (manufacturers not reported). Authors reported the fiber content ranged from 8% - 30% (by count) with an average of 19% and that the fibrous material was predominantly fibrous talc. Pooley and Rowlands (1975) analyzed twenty-seven talc powders (cosmetic and industrial) and detected tremolite fibers in three samples.

Because asbestos is a known carcinogen, its presence in cosmetic talc is unacceptable (FDA, 2012; FDA 2015). The former Director of National Institute for Occupational Safety and Health (NIOSH) and former President of Industrial Minerals Association – North America (IMA-NA) stated in a recent deposition that if there were a fiber of asbestos in talcum-based products it would “certainly” provide a biologically plausible mechanism for increased lung disease, and that he suspected it would also have a “similar mechanism of disease in other tissues and organs” (Deposition of Robert Glenn, October 18, 2018, 341:15-342:3).

In 1976, specifications were developed for cosmetic talc requiring that no detectable fibrous, asbestos mineral be present (CTFA, 1990; Fiume, 2015). The talc industry, and specifically Defendants, developed a “zero tolerance” standard for asbestos in talc (IMERYYS 170006; JNJ 000383662; JNJ 000001918). Despite this standard, the presence of asbestos in cosmetic talc has been reported in the literature, and Johnson and Johnson indicated in a letter in 1973 that “asbestos-form particles cannot be removed from talc” and that the “Johnson & Johnson process for beneficiating Vermont talc...will not guarantee a zero tolerance for elongated particles” (JNJ 000233691). In 1976, Rohl et al. tested 20 different talcs and powders including 20 body powders, baby powders, facial talcums, and also one pharmaceutical talc to determine their mineralogical and chemical composition. Where known, all were formulated prior to 1973. Of the 20 products, 9 contained detectable amounts of tremolite and anthophyllite, principally asbestiform, while some also contained fragmented forms of these minerals. The amounts ranged from tenths of a percent to over 14% by weight; two contained detectable amounts of chrysotile asbestos fiber. Eight samples contained quartz, seven ranging from 2 to 5%, with one as high as 35%. Analyses showed that the consumer products examined were rarely the pure mineral talc, but rather were mixtures of various minerals.

³ Available online at: <http://www.irsst.qc.ca/media/documents/PubIRSST/R-755.pdf>

In 1984, Paoletti et al. performed studies by electron microscopy to assess asbestos contamination in industrial and cosmetic talcs from the Italian market and the European Pharmacopoeia (Paoletti, 1984). Nine of the 25 pharmaceutical and cosmetic grade talcs contained tremolite fibers, with total percent asbestos concentrations ranging from 0.4% - 22%. About half of the talc powders revealed the presence of asbestos: in five samples chrysotile (a serpentine asbestos) was present, the others contained tremolite and anthophyllite (an amphibole asbestos).

Cosmetic and pharmaceutical talc products from deposits in Vermont, Montana, North Carolina and Alabama were examined and tested positive for asbestos (Blount, 1991). The investigator of that study recently affirmed the samples included Johnson & Johnson baby powder, purchased off the shelf (Deposition of Alice Blount, PhD, April 13, 2018). The early analytical methods used to measure asbestos fibers before 1990 were not very sensitive and thus it appears that extrapolation of the levels of asbestos from counts measured before this date could have been conservative (Blount, 1991).

In a study that examined the amphibole asbestos content of commercial talc deposits in the USA, Van Gosen et al. (2004) found that the talc-forming environment directly influenced the amphibole and amphibole-asbestos content of the talc deposit. Specifically, the study found that contact metamorphic talcs showed a strong tendency to contain amphiboles, and regional metamorphic talc bodies consistently contained amphiboles, which display a variety of compositions and habits (including asbestiform). In a German study (Mattenklott, 2007), the author examined the presence of asbestos in talc powder and found that in one-quarter of the 57 talc powder samples tested, asbestos could be detected. Two samples contained quantities exceeding 0.1 weight percent which could reach a value of 10,000 fibers/m³. This weight percent is, in some cases, half that reported by Johnson & Johnson in their internal documents, as seen in the corporate depositions reported below.

Defendants have claimed that asbestos has been “eliminated” from cosmetic talc products.⁴ However, there is substantial evidence that talcum powder products still contain asbestos, recognized as a Group 1 carcinogen. During the recent deposition of John Hopkins (Johnson and Johnson corporate representative), Mr. Hopkins affirmed testing results showing the presence of asbestos in mines from which talc ore was taken for use in Johnson & Johnson baby powder products, processed talc used in Johnson & Johnson baby powder products, and in complete Johnson & Johnson baby powder products. Those results may be found at Exhibit 28⁵ of Dr. Hopkins’ deposition. Additional examples of testing performed by and commissioned by Johnson and Johnson and Imerys may be found at Exhibit 47 to the deposition of Julie Pier, corporate representative of Imerys.⁶

In 1975, McCrone Associates also confirmed the presence of amphibole particles, alone and in bundles as seen in Defendants’ internal documents (JNJMX68_000012745). In 2004, a television station reported that Johnson’s Baby Powder had been analyzed and found anthophyllite asbestos at 0.2% (JNJ 000089413). A 1972 Johnson & Johnson document demonstrates the presence of up to 5% chrysotile in

⁴ PCPC Submission to FDA, July 2009 – “Since the early 1970’s, the relevant industries voluntarily eliminated asbestos contamination from talc products.”

⁵ Ex. 28, John Hopkins Dep. (Aug. 16 & 17, 2018; Oct. 17, 2018; and Nov. 5, 2018).

⁶ Ex. 47, Julie Pier Dep. (Sept. 12 & 13, 2018).

Johnson's Baby Powder and Shower to Shower samples (JNJ 000232996). These data clearly demonstrate the possibility for women who used talcum powder during these dates to have had exposure to this ovarian carcinogen.

Recent TEM testing on historic samples of Johnson & Johnson baby powder from 1978 showed the presence of fibrous anthophyllite in the product. (Longo and Rigler, 2018; Ex. 47, Pier Dep.). Additional TEM testing of 30 samples of Johnson & Johnson baby powder and Shower to Shower ranging in production date over a span of many years resulted in a finding of amphibole asbestos (tremolite, anthophyllite, richterite and actinolite) in 17 samples. (Longo and Rigler, 2017). Additionally, I have reviewed a recent report prepared by Dr. William Longo and Dr. Mark Rigler that reports that talcum powder products manufactured by Johnson & Johnson's Baby Powder and Shower to Shower have contained and continue to contain asbestos and talc containing asbestiform fibers (e.g. talc occurring in a fibrous habit).⁷ These results were obtained from testing talcum powder product samples manufactured during the period of the 1960s through the 1990s. Results showed 37 of 56 samples tested contained tremolite and/or anthophyllite asbestos, and 41 of 42 samples tested contained fibrous talc.

The substantial evidence of the presence of asbestos and fibrous talc in talcum powder products provides a biologically plausible explanation for the increased risk of ovarian cancer associated with the perineal use of talcum powder products.

V. HEAVY METALS

A. Properties of Heavy Metals

Nickel is classified by IARC as a human carcinogen (Group 1) (IARC, 1973, 1976, 1979, 1982, 1987, 1990). The exact mechanisms of nickel-induced carcinogenesis are not known, but likely involve genetic and epigenetic routes. Nickel (II)-induced genotoxicity may be aggravated through the generation of DNA-damaging reactive oxygen species (ROS) and the inhibition of DNA repair by this metal. Nickel exposure also causes a broad spectrum of epigenetic effects. Contact with nickel compounds can cause a variety of adverse effects on human health (Zambelli and Ciurli, 2013).

Nickel ions have been shown to cause single-strand DNA breaks and DNA-protein crosslinks (Patierno, 1985). In a study by Patierno (1985), Chinese hamster ovary cells were exposed to NiCl₂, and nickel-induced DA-protein crosslinking appeared in late S phase of the cell cycle (*Id.*). Authors associate these alterations as an early event in the process of nickel transformation (*Id.*).

Contact with nickel compounds can cause a variety of adverse effects on human health, such as nickel allergy in the form of contact dermatitis, lung fibrosis, cardiovascular and kidney diseases and

⁷ Expert Report of William E. Longo, PhD and Mark W. Rigler, PhD (Nov. 14, 2018).

cancer of the respiratory tract. Chronic non-cancer health effects may result from long-term exposure to relatively low concentrations of pollutants (Duda-Chodak and Blaszczyk, 2008). Although the accumulation of nickel in the body through chronic exposure can lead to a number of diseases, the most serious concerns relate to nickel's carcinogenic activity. Increased risks of malignant tumors, such as nasal and sinusoidal cancers, and cancers of the lung and larynx have been noted (IARC, 1987). The marked differences in the carcinogenic activities of various nickel compounds most likely reflect the differences in their uptake, transport, distribution and retention, and ultimately—the capacity to deliver nickel (II) ions to specific cells and target molecules.

In experimental animals, nickel compounds induce tumors at virtually all sites of application (Denkhaus, 2002; IARC, 1987; Zabmelli, 2013). The routes of administration that were shown to produce tumors include inhalation, intramuscular, intrarenal, intraperitoneal, intraocular, subcutaneous and the intra-articular space (*Id.*).

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and volcanic dust and gases. It comes in several different forms, including trivalent chromium (chromium (III)) and hexavalent chromium (chromium (VI)). In contrast, chromium (VI) compounds cause cancer in humans and in experimental animals and exert genetic toxicity in bacteria and in mammalian cells *in vitro* (Fang, 2014; IARC, 2009). Adverse health effects, other than cancer, associated with chromium (VI) exposure include occupational asthma, eye irritation and damage, perforated eardrums, respiratory irritation, kidney damage, liver damage, pulmonary congestion and edema, upper abdominal pain, nose irritation and damage, respiratory cancer, skin irritation, and erosion and discoloration of the teeth. Some people with extensive dermal exposure can also develop an allergic skin reaction, called allergic contact dermatitis (Bruynzeel et al., 1988). Primary irritant dermatitis is related to the direct cytotoxic properties of chromium, while allergic contact dermatitis is an inflammatory response mediated by the immune system. During reduction to the trivalent form, chromium may interact with cellular macromolecules, including DNA (Wiegand et al., 1985), or may be slowly released from the cell. Complexes of chromium (III) that are bound to lower molecular weight ligands are most likely to be able to traverse cell membranes.

Chromium (III) has weak cell membrane permeability, allowing it to cross the cell membrane, where it can bind to DNA and cause lesions, resulting in genetic damage such as strand breaks and DNA-protein crosslinks (Nickens, 2010). This damage leads to genomic instability. Another study has shown that chromium (III) causes DNA damage in cells by interfering with base pair stacking in the cell's replication cycle, and chromium (VI) intercalates DNA – both directly cause genotoxicity *in vivo* (Fang, 2014).

Hexavalent chromium compounds are classified by IARC as carcinogenic to humans (Group 1)(IARC, 2009). Mechanistically, they have been shown to cause direct DNA damage after intracellular reduction to Cr(III), mutation, genomic instability, aneuploidy, and cell transformation (*Id.*). Chromium (VI) can cause damage leading to dysfunctional DNA replication, aberrant cell cycle, DNA strand breaks, dysfunctional DNA repair and DNA-protein crosslinks and directly causing genotoxicity (Nickens, 2010).

Besides direct genotoxic effects of chromium (VI), chromium compounds such as chromate can activate transcription factors involved in inflammation and tumor growth (IARC, 1990). Major factors

governing the toxicity of chromium compounds are oxidation state and solubility. These compounds, which are powerful oxidizing agents and thus tend to be irritating and corrosive, appear to be much more toxic systemically than chromium (III) compounds, given similar amounts and solubilities. Chromium (VI) enters many types of cells and, under physiological conditions, can be reduced by hydrogen peroxide (H₂O₂), glutathione (GSH) reductase and ascorbic acid to produce reactive intermediates, including chromium (V), chromium (IV), thiyl radicals, hydroxyl radicals, and ultimately, chromium (III). Any of these species could attack DNA, proteins and membrane lipids, thereby disrupting cellular integrity and functions (De Mattia, Bravi *et al.* 2004). Besides cancer, chromium is one of the most common skin sensitizers. It also causes toxicity of the kidney, liver, gastrointestinal tract, and cardiovascular, hematological and reproductive systems along with causing developmental effects.⁸ High doses of chromium (VI) compounds have been reported to cause developmental toxicity in mice and shown to potentiate the effects of other toxicants, including the nephrotoxins, mercuric chloride, citrinin, hexachlorobutadiene, and maleic acid.

Cobalt IARC declared that cobalt metal with tungsten carbide is *probably carcinogenic to humans (Group 2A)*, while cobalt metal without tungsten carbide is *possibly carcinogenic to humans (Group 2B)*. Two different mechanisms of genotoxicity, (1) DNA breakage induced by cobalt metal and especially hard metal particles, and (2) inhibition of DNA repair by cobalt (II) ions contribute to the carcinogenic potential of cobalt compounds (Lison et al., 2001; IARC, 2006). Cobalt can also contribute to allergic reactions. In humans, gastrointestinal absorption of cobalt has been reported to vary between 5 and 45% and it has been suggested that absorption is higher in women than in men. Cobalt can be absorbed through intact human skin (IARC, 2006). Soluble cobalt salts interfere adversely with cell division, bind irreversibly to nucleic acids in the cell nucleus, induce chromosome aberrations in plants, and are weakly mutagenic in some *in vitro* tests. Injections or implantation of cobalt metal, alloys and compounds induced local and sometimes metastasizing sarcomas in rats, rabbits, and mice (*Id.*). Data indicating possible carcinogenic effects of cobalt alloys or compounds in human populations has arisen from medical use, use in hard-metal industries, and from cobalt production sites.

B. Metals in Talcum Powder Products

In an early paper by Cralley et al., (1968), 22 cosmetic talcum products purchased off the shelf were analyzed for fibrous content, selected metals and quartz. In these studies, 19 samples contained cobalt under 25 parts per million (ppm) by weight, chromium under 22 ppm, nickel below 29 ppm and manganese under 78 ppm. Certain samples had a nickel content of 1270 ppm, chromium 340 ppm and 1210 ppm nickel; qualitative tests demonstrated that some of the chromium was hexavalent (carcinogenic form). All of these talcs had a considerable fiber content (suggesting the presence of asbestos) (*Id.*). Studies here suggest that women who used talcum powder in the 1960s could have been exposed to considerable amounts of toxic heavy metals depending on the type of talc used and frequency of use (*Id.*).

⁸ Accessible online at: <https://www.atsdr.cdc.gov/csem/csem.asp?csem=10&po=10>

In a 2013 study by Rehman, toxic and carcinogenic heavy metals were found to be present in small amounts in all 30 brands of cosmetic talcum powder tested; the concentrations of heavy metals differed dramatically depending upon the brand of talcum powder (Rehman, 2013). Heavy metals measured (and found in samples) included cadmium, chromium, copper, cobalt and lead. Authors found all levels to be within safe limits. However, authors caution that excess use of talcum powder affects the health of the consumer (*Id.*).

In a paper by Gondal et al. (2012), published in Applied Optics, lead and chromium were measured in talcum powder using laser-breakdown spectroscopy. Using this system, the authors were able to detect 15-20 parts per million (ppm) of lead and 20-30 ppm of total chromium in the talcum powder sample. This study, like that by Rehman, demonstrates the presence of toxic heavy metals associated with talcum powder. However, the levels of heavy metals in this study were significantly higher. The method used for measuring metals in this study was far more precise than that used by Rehman et al. (2013). This study supports the presence of toxic and potentially carcinogenic metals in some talcum powders.

According to Johnson & Johnson's corporate representative, the maximum amount of allowable nickel in the company's talcum powder products was 5 ppm (Deposition of John Hopkins, August 16, 2018, Ex. 3). Written specifications state that the maximum allowable nickel content is 10 ppm (JNJ 000629320; JNJ000488188; JNJMX68_000022920). Despite these limits, nickel in concentrations exceeding 2000 ppm were reported in Vermont talc used in talcum powder products for decades, greatly in excess of the product specification limit of 10 ppm (JNJ 000629320; JNJ 000488188; JNJMX68_000022920). Examples of testing results for heavy metals in Defendants' talcum powder products can be found in **Exhibit C**, attached to this report.

Over the years from 1972 to 2004, talc mined in Vermont had consistent, excessive levels of nickel, routinely exceeding 94 to 250 times the upper limit provided in J&J's specifications (Exhibit C). This is troubling considering nickel is a known carcinogen (IARC 2012).

Cobalt was found in Vermont talc ores in amounts ranging from 8 – 89 ppm from 1972 through 2004. Like nickel it, too, appears to occur routinely in talc products in amounts exceeding the 10 ppm upper limit for heavy metals in the talc product specifications (Exhibit C).

Internal documents outline Johnson & Johnson's concern regarding the potential carcinogenic nature of chromium (VI), a Group I carcinogen (JNJ 000131758; JNJ 000131754; JNJ 000378044; JNJ 000378046). A 2010 J&J memo written discusses raising the upper limit acceptable for total Cr to 7 ppm (JNJ 000131758). An accompanying memo also discusses the relationship between chromium (III) and chromium (VI) (JNJ 000131754), and a discussion of the inhalation of hexavalent chromium is contained in this document. Regardless of valence, Grade 66 analyses consistently show total chromium contents far in excess of 5-, 7-, or 10 ppm. During the period from 1972 thru 2004, the chromium content varied from 25 ppm to 569 ppm (Ex. 47, Pier Dep.), with typical levels around 200 ppm.

Interestingly, there is a significant difference between the reported chromium content of Grade 66 talc when the sample has been prepared by Johnson & Johnson (internal) method BPT 148 versus the

United States Pharmacopeia (USP) method which uses a total digestion technique (IMERYS-A_0015621). The levels reported using the USP method were much higher than the Johnson & Johnson method (*Id.*).

C. Fragrances

There are more than 150 different chemicals added to Johnson's Baby Powder and Shower to Shower products. I reviewed the expert report from Dr. Michael Crowley that concludes that some of these chemicals may contribute to the inflammatory response, toxicity, and potential carcinogenicity of Johnson & Johnson's talcum powder products.⁹ I concur with his opinion.

There is substantial evidence that talcum powder products contain excess levels of nickel, chromium, and cobalt, all known carcinogens and/or inflammatory agents. Moreover, a significant number of the fragrance chemicals added to talc elicit an inflammatory response. Each of these elements individually and together can contribute to an inflammatory response caused by the product. As will be explained in more detail below, inflammation is a known mediator of ovarian cancer. The presence of these inflammatory agents provides additional biologic evidence explaining the causal relationship between genital use of talc and ovarian cancer.

VI. EXPOSURE – TALC PARTICLE ACCESS TO THE BODY

A. Exposure Routes

Based on the tenets of toxicology, there are four basic routes of human exposure including: inhalation, ingestion, dermal and injection.

A common exposure route for cosmetic talc is via the dermal route, including vaginally after perineal application. Talc body powders are often applied to the perineum for hygienic purposes. It has been shown that glove powder and other materials can migrate upwards through the female reproductive tract (Venter & Iturralde, 1979; Iturre and Venter, 1981; Sjosten et al., 2004; Heller et al., 1995) and the data are supported by animal investigations (Wright et al., 1996; Edelstam et al., 1997; De Boer, 1972; Henderson et al., 1986), also reflective of a dermal exposure route.

Inhalation is the route of exposure that has been most commonly studied to assess talc toxicity. In one inhalation study, after talc exposure of hamsters, there was a consistent elevation in cytotoxic enzyme levels, and macrophage phagocytosis was persistently depressed (Beck et al., 1987). These results also indicated that, when a similar mass of talc and granite dust (12% quartz) was deposited in the lungs,

⁹ Expert Report of Michael Crowley, PhD (Nov. 12, 2018).

talc caused more lung injury than did granite (*Id.*). Based on its physical properties talc, in a powder form, can be inhaled while being applied (EPA, 1992; IARC, 2010). Additional evidence that application of talc body powder products results in inhalation exposure of talcum powder is provided in a 2017 study by Longo, et. al., and other studies (Longo, September 2017, “*Below the Waist Application of Johnson & Johnson Baby Powder*”; Wells, 1979; van Huisstede, 2010; Frank and Jorge, 2011; Jasuja, 2017).

1. Dermal - Migration Through the Upper Genital Tract

Animal models: Though animal studies have limitations due to the differences in anatomy, they provide evidence that talc can migrate through the reproductive system. Rats were exposed vaginally or via the perineum to either talc or no treatment for 3-mo on a daily basis (Keskin et al., 2009). In this study, there was evidence of foreign body reaction and genital infection, along with an increase in inflammatory cells in all the genital tissues. While no neoplastic changes were observed, the number of ovarian follicles in the talc groups were increased. No peritoneal changes were observed. The investigators concluded that talc by perineum exposure has adverse effects on the genital system in the form of foreign body reactions and infection (*Id.*).

In a series of two experiments, Henderson et al. (1986) demonstrated the presence of talc in the ovaries of two groups of animals following vaginal and intrauterine talc applications, whereas none was present in the ovaries of control animals. Particles were also seen in animals that had received intravaginal talc that were sacrificed after 4 days. (*Id.*)

Studies by Wright et al. (1995) also demonstrated the potential toxicity of retrograde uterine passage of particulate matter. Despite the aforementioned studies which demonstrate the plausibility of talc translocation, a study by Wehner et al. (1996) failed to demonstrate the same outcomes in a small sample of monkeys, which may have been due to the small sample size.

Human studies: A number of human studies over many years have observed migration of particles following vaginal administration: these studies began as early as 1961 when Egli and Newton studied the translocation of carbon particles following vagina application. In 1972, De Boer deposited colloidal carbon black (CB) suspension in the uterus, cervical canal or vagina in over 100 patients prior to surgery (De Boer, 1972). Subsequent observation revealed rapid translocation of CB to the oviducts and beyond. Some CB deposited in the cervical canal also translocated to the uterine passage, albeit in a lower percentage of patients (*Id.*). An early study by the National Institute of Occupational Safety and Health (NIOSH) in 1972 showed commercially available talc body powder samples contained fibers, and that exposure to fibers occurred during diapering (JNJ 000231304).

A study by Venter and Itteralde (1979) administered radiolabeled human albumin microspheres (no size provided) in the vagina of patients, followed by surgical removal of uterus, oviducts and ovaries. Results demonstrated that 9 out of 14 patients had radioactivity in their oviducts and ovaries. Recent studies have demonstrated the presence of talc particles in ovarian tumors (to be discussed in a later section). Another clinical study examined a total of 24 women undergoing oophorectomy (Heller et al.,

1995). In this case, women were questioned as to their use of perineal talc applications. Ovarian tissue was removed from each group and analyzed and quantitated for talc by polarized light and electron microscopy. These data support the ability of talc to migrate from the perineal region upward and reach the upper genital tract (*Id.*).

Further evidence for migration of particles to the upper genital areas comes from a document from the FDA to Dr. Epstein (Cancer Prevention Coalition, University of Illinois, Chicago) concerning Citizen Petitions dated 1994 and 2008 and requesting a cancer warning on cosmetic talc products. In this document, the FDA stated that “the potential for particulates to migrate from the perineum and vagina to the peritoneal cavity is indisputable” (JNJ 000488318).

In addition, a 2004 document from Luzenac America to Dr. Al Wehner (IMERYS 137677) recalls a 2004 published paper by Sjosten et al. (2004). Luzenac states that the paper “offers some compelling evidence **in support** of the ‘migration’ hypothesis.” The paper concluded that starch particles migrate from the vagina through the Fallopian tubes up to four days after examination with powdered gloves (*Id.*). The author of the Luzenac document goes on to state that combining this evidence with the theory that talc initiates epithelial inflammation and you have a “potential formula” for the NTP classification of talc as a carcinogen.

The most recent systematic review of the association between genital use of talcum powder products and ovarian cancer (Penninkilampi, 2018) reported an increased risk of ovarian cancer with increased perineal talcum powder use, with a slightly higher risk in women who report greater usage. Data was collected as “lifetime” usage – frequency of use over time. Any use was associated with increased risk of ovarian cancer as compared to no use, and women with long-term (> 10 years) talcum powder use had an increased risk. The authors concluded perineal talcum powder use and ovarian cancer were consistently associated, with a slightly higher risk in women who report greater usage.

Pathways that allow for the migration of particles to the lymph nodes are also available for that complex portion of the lymphatic system surrounding the ovaries. Importantly, studies by Chan et al. (2007) have demonstrated a positive association between lymphadenectomy and survival in stage 1 ovarian cancer patients. In support of this finding, Cramer et al. (2007) described the presence of talc particles in pelvic lymph nodes of a woman with ovarian cancer and long-term genital exposure to cosmetic talc.

Animal and human studies demonstrate that talcum powder products can migrate from the perineal region to the ovaries.

2. Inhalation

Effects of size on particle translocation and toxicity have been studied most extensively with inhaled particulate air pollutants and nanomaterials. These studies will be discussed to provide a scientific

premise for movement of particles of a certain size throughout the body. Small-sized particles can enter the bloodstream – translocation of particles and often toxicity are related to their size; perhaps because of the larger mass concentration of smaller vs. larger particles (Driscoll et al., 1997).

J&J's analysis of particle size in talcum powder products shows particles range on average from 0.8 μm to over 50 μm , with a median particle size of 11.39 μm , where approximately 43.9% of particles are less than 10 μm (JNJALC000878141).

Ultrafine particles (UFPs; $< 0.1 \mu\text{m}$) can directly affect the cardiovascular system by migration from the respiratory system to the systemic circulation (Nakane, 2012; Elder et al., 2006; Kreyling et al., 2006). Inhaled UFPs deposited in the lung can pass through the epithelial barrier because of their very small size; some particles may move into lung capillaries and then into the systemic circulation. Numerous studies and reviews have been written concerning the migration of these particles. In a systematic literature review (Nakane, 2012), particle size was shown to be a strong factor for migration. Particles that were translocated to various sites were observed to have the following sizes: $\leq 0.05 \mu\text{m}$ for remote organs, $\leq 1 \mu\text{m}$ for blood, and $\leq 10 \mu\text{m}$ for lung tissues. In order to be detected in the blood, particles that have passed through the epithelial barrier of the lungs must migrate into the capillaries. The largest chance for migration to the brain was observed at a 0.05- μm cutoff size. However, MnO_2 particles as large as 1.3 μm have also been detected in the cerebral cortex (Nakane, 2012). A categorical regression analysis based on currently available inhalation data showed that all of the effects of particle size, particle material, animal species, and exposure route were statistically significant (*Id.*). The effects were large for particle size and particle material, and small for exposure route and animal species. These results suggest that, in an experiment to evaluate the migration of solid particles, the characteristics of the particles (i.e., size and material) should be considered carefully.

Evidence from an internal document (1971) demonstrates rolled talc fibers between 0.1 - 3 μm in a Johnson and Johnson's commercial product (JNJAZ55_000005957). Other documents from Defendants have demonstrated that while median particle size is $\sim 10.5 \mu\text{m}$, sizes can be as small as 0.3 μm (IMERYS030347; IMERYS031791). V66 non-shear talc was approved for use in JNJ Shower to Shower products and the size of some of the particles had a diameter as small as 0.1 μm (JNJALC000878141). While the median particle size was $\sim 12 \mu\text{m}$, the standard deviation was very high ($\sim 9 \mu\text{m}$) demonstrating a large range of particle sizes. Fine-size particles such as those found in talc, can also translocate readily throughout the body (Peters et al., 2006), providing a strong basis for the ability of fine-size talc particles ($< 2.5 \mu\text{m}$ to migrate throughout the body).

Ultrafine and fine particles can penetrate through the different tissue compartments of the lungs and eventually reach the capillaries and circulating cells. These particles are then translocated by the circulation to other organs including the liver, the spleen, the kidneys, the heart and the brain, and the ovaries where they may be deposited. It remains to be shown by which mechanism(s) ultrafine particles penetrate through tissue and enter capillaries. Lymph capillaries remove the large protein molecules and other particulate matter from the tissue spaces of the lung. Thus, cellular debris and foreign particles inhaled into the lungs can be conveyed to the regional lymph nodes.

Talc particle size analyses for many inhalation studies demonstrated that most talc particles were between 1 and 8 μm ; 1 μm is considered ultrafine in size and thus particles could easily migrate from the lungs and throughout the body. Genofre et al., (2009) examined the effect of talc particle size on induced pleurodesis following intrapleural injection of rabbits with two different sizes of talc. One group contained mixed sizes of talc (mean size = 25.4 μm) and the other group small size talc only (mean size = 4.2 μm with 50% <6.4 μm) (*Id.*). Particles of both sizes migrated to the spleen, liver and kidney; more small talc particles (compared to mixed talc) was seen in the liver and kidneys. Both size particles produced an acute systemic inflammatory response, with small particle talc producing a more pronounced pleural and systemic response and resulting in greater particle deposition in the organs than the mixed talc (*Id.*). In addition, serum levels of the pro-inflammatory cytokine, IL-8 and VEGF were more markedly increased in the small talc group (*Id.*). Particles found in all systemic organs were <5 μm . A number of other studies have shown migration of talc particles from the pleural cavity to the systemic circulation (Ferrer, 2002; Rossi, 2010). It appears that small particles may be more easily taken up by the lymphatics than larger particles. The inflammatory effects observed showed a strong correlation with the small particle group. This study shows that size of talc particles matter and the smaller the size the greater the ability to translocate and increase the extent of the inflammatory response. As Defendants' internal documents demonstrate their talc particle size to cover a wide size range (100 μm to ~0.3 μm)¹⁰, there is extensive evidence that particles can be inhaled and transported through the blood and lymph to the ovaries.

In 1993, the National Toxicology Program (NTP) issued a report from a study concluding that there was "some evidence of carcinogenic activity" in male rats, "clear evidence of carcinogenic activity" in female rats, and no evidence of carcinogenic activity in male or female mice exposed to aerosols of talc reported as nonasbestiform cosmetic-grade (National Toxicology Program, 1993). Authors of that study speculated these effects could be due to cytokines released from macrophages or a nonspecific effect of the stress of inflammation (*Id.*).

In another study, rabbits were injected with normal size talc ($D_{\text{max}} = 8.36 \mu\text{m}$) or larger particles talc ($D_{\text{max}} = 12 \mu\text{m}$) (Ferrer et al., 2002). Pleural inflammation was greater with normal talc than large talc, and animals receiving normal talc had talc particles in the liver, supporting the premise that talc particles instilled into the pleural cavity can escape and migrate to extrapleural organs. Talc dissemination can be significant, and granulomas have been seen to develop in the interstitium after particles migrate from the lungs, with resultant pulmonary interstitial fibrosis (Hollinger, 1990). In another study illustrating talc dissemination (Werebe, 1999), talc was administered into the pleural space of rats. At both 24- and 48-hours, talc crystals were found in every organ of all animals, with the amount of talc being statistically different between the organs. Authors concluded there was a rapid absorption of talc through the pleural surface and a progressive systemic distribution of particles (*Id.*).

In addition to migration of ultrafine particles through tissue and movement to the lymph nodes, fine and coarse particles may be phagocytized by macrophages and dendritic cells which may carry the particles to lymph nodes in the lung or to those closely associated with the lungs (IARC, 2010). The uptake of fine particles (0.1–2.5 μm in diameter) by macrophages is a specific ligand-receptor mediated

¹⁰ IMERY346016; IMERY3030347; IMERY3031791; JNJAZ55_000005957.

actin-based process (phagocytosis), whereas the uptake of ultrafine particles ($<0.1\ \mu\text{m}$ in diameter) apparently occurs by other, non-specific mechanisms (Peters, 2006). These mechanisms are termed “adhesive interactions,” and include electrostatic, van der Waals and steric interactions (*Id.*). Particles with a diameter of $0.2\ \mu\text{m}$ and smaller appear to enter cells passively, that is by a mechanism which is different from phagocytosis. Larger particles are much more avidly taken up by macrophages, but by the specific receptor mediated, actin-dependent mechanism. Below the particle size of $0.2\ \mu\text{m}$, particles increasingly enter the macrophages by the non-specific “adhesive interaction” mechanisms mentioned above (*Id.*).

There is substantial evidence in the scientific and medical literature that support a conclusion that talc powder particles can reach the ovaries through inhalation.

VII. MECHANISM OF CANCER

A. Cancer - General

Tumorigenesis, the formation and growth of tumors, is a complex and multifactorial progressive process of transformation of normal cells into malignant ones (Pogribny and Rusyn, 2014). It is characterized by the accumulation of multiple cancer-specific heritable phenotypes, including persistent proliferative signaling, resistance to cell death, evasion of growth suppression, replicative immortality, inflammatory response, deregulation of energy metabolism, genomic instability, induction of angiogenesis, and activation of invasion ultimately resulting in metastases. It encompasses genetic, behavioral, and environmental factors that can all contribute to its development.

Mutations can occur as a result of the processes inside the cell, or alternatively, can be caused by external factors, such as chemicals. In addition, some people can inherit faults in particular genes that make them more likely to develop cancer. While normal cells obey signals indicating they have reached their growth limit, in cancer cells, the normal signaling system is disrupted. Mutations in particular genes may result in over- or under- production of proteins, or the production of abnormally formed proteins, all of which can lead to a lack of cellular regulation.

In general, cancer is an uncontrolled growth of abnormal cells in the body, which occurs when the body’s normal control mechanisms are disrupted. Excessive cellular division leads to a growth called a tumor. Mutations can happen by chance when a cell is dividing. Some mutations act by inhibiting normal controls over cell growth, leading to uncontrolled cell division. DNA may be damaged during routine cellular processes, and cells have mechanisms to repair that damage. However, over time, the damage may accumulate. Once cells exhibit increased cell growth, they are more likely to pick up additional mutations and are less likely to be able to repair the damaged genes.

If the DNA damage cannot be repaired, the cell can self-destruct, a process called apoptosis. In cancer cells, molecules in the repair pathway are faulty. For example, a protein called p53 normally determines whether genes can be repaired or if the cell should undergo apoptosis. Many cancers have a defective version of p53, and don't repair themselves properly. Thus, cancer cells can override self-destruct signals and don't undergo apoptosis when they should.

B. Genetic Mutations

Inherited mutations are passed down from parent to child and are present throughout a person's life in virtually every cell in the body. These mutations are also called germline mutations because they are present in the parent's egg or sperm (germ) cells. When an egg and a sperm cell unite, the resulting fertilized egg cell receives DNA from both parents. If this DNA has a mutation, the child that grows from the fertilized egg will have the mutation in each of his or her cells.

A genetic predisposition (sometimes also called genetic susceptibility) is an increased likelihood of developing a particular disease based on a person's genetic makeup. A genetic predisposition results from specific genetic variations that are often inherited from a parent. These genetic changes contribute to the development of a disease, but do not directly cause it. For example, mutations in the *BRCA* gene result in an increased risk for ovarian cancer. Some people with a predisposing genetic variation will never get the disease while others will, even within the same family. Genetic variations can have large or small effects on the likelihood of developing a particular disease. Although each of these variations only slightly increases a person's risk, having changes in several different genes may combine to increase disease risk significantly. Changes in many genes, each with a small effect, may underlie susceptibility to many common diseases, including cancer.

In people with a genetic predisposition, the risk of disease can depend on multiple factors in addition to an identified genetic change. These include other genetic factors (sometimes called modifiers) as well as lifestyle and environmental factors. Diseases that are caused by a combination of factors are described as multifactorial. Most disease-causing gene mutations are uncommon in the general population. However, other genetic changes occur more frequently. Genetic alterations that occur in more than 1 percent of the population are called polymorphisms.

Acquired (or somatic) mutations occur at some time during a person's life and are present only in certain cells, not in every cell in the body. These changes can be caused by environmental factors such as ultraviolet radiation from the sun, chemical exposure, or can occur if an error is made as DNA copies itself during cell division. Acquired mutations in somatic cells (other than sperm and egg cells) cannot be passed to the next generation.

Environmental and occupational exposures to natural substances, as well as man-made chemical and physical agents, play a causative role in human cancer. Acquisition of cancer-specific alterations may be triggered by the mutational and/or non-mutational (i.e., epigenetic) events in the genome which, in turn, affect gene expression and downstream phenotypes including persistent proliferative signaling, resistance to cell death, evasion of growth suppression, replicative immortality, inflammatory response,

deregulation of energy metabolism, genomic instability, induction of angiogenesis, and activation of invasion ultimately resulting in metastases.

Genotoxic carcinogens are agents that interact directly or after metabolic activation with DNA, causing mutations and leading to tumor formation. Non-genotoxic carcinogens are a diverse group of chemical compounds that are known to cause tumors by mechanisms other than direct damage to DNA. In a broad sense, carcinogenesis may be induced through either genotoxic or non-genotoxic mechanisms. However, both genotoxic and non-genotoxic carcinogens also cause prominent epigenetic changes (Pogribny and Rusyn, 2013). Disruption of epigenetic processes can lead to altered gene function and malignant cell transformation. Global changes in the epigenetic landscape are a hallmark of cancer.

The presence of talc particles in the ovaries (deep in the tumor) of some ovarian cancer patients and presence of talc in pelvic lymph nodes provides indirect evidence for talc carcinogenicity (Heller et al., 1996). Changes in signal transduction pathways that lead to increased and chronic inflammation are also associated with cancer, as are changes in cancer stem cells which have the ability to generate tumors through the processes of self-renewal and differentiation into multiple cell types. Cancer stem cells are thought to play a major role in tumor escape, chemoresistance/recurrence of ovarian cancer. Users of talcum powder have lower plasma levels of anti-MUC1 antibodies than non-users (Karageorgi et al., 2010). MUC1 is a protein highly expressed by ovarian, breast, and endometrial tumors, and low levels of anti-MUC1 antibodies are associated with poorer prognosis. Reducing immunity to MUC-1 could be one mechanism by which talc increases endometrial and/or ovarian cancer risk (Karageorgi et al. 2010).

C. Ovarian Cancer

There are two major categories of ovarian carcinogenesis based on the idea that tumors are heterogeneous: high-grade malignancies that tend to be fast growing and chemo-sensitive, and low-grade neoplasms which typically grow slowly, but are less sensitive to chemotherapy. The low-grade pathway is associated with a stepwise mutation process, whereas the high-grade develops through genetic instability (Lengyel, 2010). Ovarian cancer comprises at least five distinct histological subtypes, the most common and well-studied being high-grade serous ovarian cancer. The majority of these tumors arise from the distal end of the fallopian tube and evolve from premalignant lesions called tubal intraepithelial carcinoma (Saad, 2010). Several risk factors have been associated with increased risk of ovarian cancer and include: low parity, infertility, early age of menarche and late age of menopause.

Multiple mechanisms can explain the progression of ovarian cancer (Fleming et al., 2006; Fathalla, 2013; Saad, 2010; Smith and Xu, 2008). These mechanisms include: incessant ovulation- whereby repeated damage and trauma to the ovarian epithelium during ovulation increases the risk for genetic mutation and ovarian neoplasm during epithelium repair; pituitary gonadotropin changes- high levels of gonadotropins increase estrogen stimulation which can cause ovarian epithelial cells to become entrapped in inclusion cysts that undergo malignant changes; androgen/progesterone alterations- androgens stimulate ovarian cancer formation and progestins are protective; inflammation- factors that predispose to inflammation, such as endometriosis, PID, perineal talc use and hyperthyroidism could stimulate ovarian cancer. The molecular pathway in the inflammatory process involves intracellular

effectors implicated in malignant transformation such as VEGF, NF- κ B, nitric oxide synthase, and cyclooxygenase (Williams et al., 1999).

Genetic mutations also play a role in the development of ovarian cancer. For example, certain mutations in the *BRCA1* or *BRCA2* genes increase a person's risk of developing ovarian cancer. Both inherited and acquired gene mutations work together to cause cancer. Even if one has inherited a genetic mutation that predisposes one to cancer, that doesn't mean he or she is certain to get cancer. Rather, one or more additional gene mutations may be needed to cause cancer. The inherited gene mutation could instead make one more likely to develop cancer when exposed to certain cancer-causing substances.

D. Roles of the Immune System

It is well established that inflammation has paradoxical roles during tumor development (Coussens and Werb, 2002). While acute inflammation can be protective against tumors, chronic inflammation provides an environment for the tumor to thrive. The net outcome of tumor-associated inflammation depends on the dominance of either tumor-promoting or tumor-suppressive actions. Inflammation normally functions to maintain tissue homeostasis in response to tissue stressors such as infection or tissue damage. However, studies also suggest a close association between inflammation and tumorigenesis (Rakoff-Nahoum, 2006).

Two stages of inflammation exist, acute and chronic inflammation (Ingersoll, 2011). Acute inflammation is an initial stage of inflammation (innate immunity), which is mediated through the activation of the immune system. This type of inflammation persists only for a short time and is usually beneficial for the host. Acute inflammation (e.g., involving innate immunity, macrophages, natural killer cells, neutrophils) frequently precedes the development of protective adaptive immune responses to pathogens and cancer.

Chronic inflammation, by contrast, has been shown to contribute to tumorigenesis at all stages (Crusz and Balkwill, 2015). It contributes to cancer promotion by inducing cellular proliferation; and to cancer progression by enhancing angiogenesis and tissue invasion. Over time, chronic inflammation can cause DNA damage and lead to cancer. Inflammation initiated by genital application of talc is likely to be sustained, since studies indicate that women start using talcum powder at an early age and continue using it for decades.

E. Ovarian Cancer and Inflammation

Inflammation plays an important role in the progression of ovarian cancer, and it is a biologically plausible mechanism that mediates ovarian cancer. Recent clinical and prospective data suggest that C-reactive protein (CRP), a marker of global inflammation, is associated with increased ovarian cancer risk (Li, 2017; Poole, 2013; Jing, 2017). Other inflammatory markers may be important in ovarian carcinogenesis. In premenopausal women, ovarian epithelial cells secrete cytokines as part of ovarian function and some of these cytokines are also produced by ovarian cancer cells (Jammal, 2016). Epithelial

cells in proximity to ovulating follicles are likely exposed to these inflammatory mediators that may signal oxidative stress, and enhance the risk of mutagenesis. Importantly, cytokines involved in ovarian function, follicle rupture, and repair (physiologic processes before menopause) are suggested to remain activated in postmenopausal women and may play an etiologic role in ovarian carcinogenesis; these cytokines include: interleukin (IL)-1 α , IL-1 β , IL-2, IL-6, IL-8, IL-10, tumor necrosis factor alpha (TNF- α), interferon gamma (IFN- γ), granulocyte colony-stimulating factor (G-CSF), and granulocyte macrophage colony-stimulating factor (GM-CSF). Many inflammatory mediators, including prostaglandins, leukotrienes, and cytokines, are locally elevated during ovulation. Epithelial cells in proximity to ovulating follicles are likely exposed to these inflammatory mediators that may signal oxidative stress, and enhance the risk of mutagenesis. Moreover, IL-8, an important angiogenesis factor, is elevated in ovarian cancer patients and is believed to be a key factor for cancer growth and new vessel formation (Lane, 2011). Additionally, Saed et al. (2017) has reported that oxidative stress can play an important role in the pathogenesis, neoangiogenesis and dissemination of local or distant ovarian cancer.

Endometriosis is a pelvic disorder associated with inflammation and scarring. Studies also link endometriosis with the increased risk of epithelial ovarian carcinoma through pathways related to oxidative stress and inflammation (Melin, 2006; Worley, 2013). Studies indicate that women with endometriosis differ in the expression of inflammatory mediators, and changes in the cytokine network indicating immune dysregulation, which could contribute to the development of endometriosis (Pizzo, 2002). Wu et al. (2009) performed a study to determine the role of talc in the development of ovarian cancer, considering the history of endometriosis. Results demonstrated an increased risk of ovarian cancer with increasing frequency and duration of talc use; compared to never users, risk was highest among long duration, frequent talc users. A history of physician-diagnosed endometriosis was significantly associated with ovarian cancer in risks, and women who were talc users and had a history of endometriosis showed a 3-fold increased risk, and authors concluded risk of ovarian cancer is significantly associated with talc use and a history of endometriosis.

VIII. MECHANISM OF INFLAMMATION

Inflammation has long been associated with the development of cancer (reviewed by Heidland, 2006; Balkwill, Mantovani, 2001; Rakoff-Nahoum, 2006; Todoric, 2016). An inflammatory process begins when chemical mediators are released by the damaged tissue. The inflammatory response orchestrates host defenses and mediates tissue repair and regeneration in response to damage from chemical toxicants, foreign organisms or carcinogens. Epidemiological evidence points to a connection between inflammation and a predisposition for the development of cancer, i.e., long-term inflammation leads to the development of dysplasia (abnormal cell growth preceding cancer).

Inflammation is a well-established risk factor for all stages of carcinogenesis and tumor progression (Chow, 2012), including ovarian cancer (Maccio and Madeddu, 2012). Inflammation is a factor in a number of mechanisms regarding the etiology of epithelial ovarian cancer and a contributor to

ovarian tumor development and tumor progression (reviewed in Ness, 1999). Inhibition of inflammatory cytokines in the tumor milieu acts on inflammatory-induced angiogenesis and apoptosis and improves prognosis. In a review paper by Ness and Cottreau (1999), talc and asbestos are discussed as risk factors for ovarian cancer, along with endometriosis and pelvic inflammatory disease which are all associated with induction of local cancer.

A. Cytokine Networks

The cytokine networks are very active in producing pro-inflammatory cytokines, growth factors, and chemokines, all of which are molecules active in immune system signalling. There is evidence that inflammatory cytokines and chemokines, which are produced by tumor cells and/or tumor-associated leukocytes, may contribute directly to malignancy. Tumor necrosis factor (TNF)-alpha, a major mediator of inflammation, has actions directed towards both tissue destruction and recovery. TNF can be detected in malignant and/or stromal cells in human ovarian, breast, prostate, bladder and colorectal cancer, lymphomas and leukemias and often is associated with IL-1 and -6 and macrophage colony stimulating factor. TNF- α is also implicated in the induction of a chemokine called MCP-1 which can regulate the macrophage and lymphocyte infiltrate and of MMP-9 in the ovarian tumor microenvironment. There is also evidence for pro-cancer actions of TNF- α in animal models. The molecular basis is thought to involve induction of ROS in the form of NO synthase. NO can directly oxidize DNA, resulting in mutagenic changes, and may damage some DNA repair proteins. Inducible NO synthase has been detected in gynecological cancers, including ovarian cancer.

B. Macrophages

The neoplastic process which consists of proliferation, survival and migration is linked with the tumor microenvironment and synchronized with the influx of inflammatory cells, including neutrophils and macrophages which are a main source of exogenous reactive oxygen species (ROS) (Forman and Torres, 2002). Macrophages and the innate immune system can be responsible for tissue injury, when in excess or continuous.

This can also indicate macrophage activation leading to excess production of other macrophage-generated mediators, including cytokines. Macrophages can engulf talc particles and play a critical role in disease. Moreover, macrophages are the major constituents in granulomas. Talc can promote murine macrophage survival and DNA synthesis *in vitro* (Hamilton, 2001). Such enhancement of macrophage survival by talc, if it occurred *in vivo*, could lengthen the cells' tenure in a lesion with the result that more cells would be present to produce inflammatory mediators, such as cytokines, proteinases, and eicosanoids, perhaps potentiated by additional stimuli. This could be another mechanism as to how macrophage cell numbers increase in talc-induced granulomas and inflammatory reactions.

In a 2005 *in vitro* study (Bogatu and Contag, 2005), talc (as a fibrogenic dust) was shown to adsorb high density lipoprotein (HDL). The authors concluded that the adsorption of HDL could have a "causal relationship" with triggering of a fibrotic reaction. The adsorption on the surface of fibrogenic dust particles, including talc provides an opportunity for the intake of HDL by macrophages which then

release an increased amount of fibrogenic mediators. Coating of talc by HDL allows for more rapid uptake by the macrophage as it can use multiple receptors as points of entry into the cell. In general, surfaces of all fibrogenic particles, such as talc, have a specific property which is lacking in non-fibrogenic (inert) particles or is at least significantly less effective. However, even upon overloading, non-fibrogenic dusts cannot produce fibrosis.

In another study (Ghio et al., 2012), both mesothelial and airway epithelial cells exposed to talc significantly increased iron importation and concentration of the iron storage protein, ferritin. The production of pro-inflammatory cytokines was also induced by *in vitro* talc exposure relative to control lung tissue, and a time-dependent and concentration-dependent release of oxidants was observed in both cell types. Talc toxicity was also observed in an *in vitro* study comparing effects of micro-scale talc particles with those of smaller nanotalc particles on lung cells (Akhtar, 2010). Cell viability was decreased for all talc exposures, and decreased as a function of talc concentration, origin and particle size. Nanotalc particles differentially induced lipid peroxidation, reactive oxygen species and depletion of the anti-oxidant, glutathione. Further, data suggests that talc toxicity was mediated through oxidative stress.

A study by Khan et al. (2011) demonstrated that nanoscale talc, as opposed to larger talc particles enhanced its cytotoxicity. In this study, macrophages exposed to nanotalc increased the manufacture (transcription) of three macrophage-released pro-inflammatory cytokines and the phosphorylation of two signal transduction pathways. The authors indicated that the inflammatory potential of nano talc particles might be (at least partially) a potential mechanism in talc-mediated pathogenicity.

An early study (Davies et al., 1983) in which the cytotoxicity of seven talcs was evaluated using rat peritoneal macrophage demonstrated modest, but consistent macrophage cytotoxicity visualized by an increase in macrophage production of two enzymatic cell injury markers including lactate dehydrogenase (LDH) and B-glucuronidase (compared to *in vitro* treatment with a non-fibrogenic dust. This study points to the potential of talc to “activate” macrophage leading to increased production of macrophage-released mediators including pro-inflammatory cytokines. Some investigators have suggested such *in vitro* macrophage changes could predict fibrogenicity *in vivo*. Based on talc chemical analyses, the authors concluded that effects on macrophages were not due to contaminating minerals.

In a molecular cell study by Shukla et al. (2009), non-fibrous-containing talc at low concentrations caused increased expression of the gene Activating Transcription Factor (ATF genes modulates production of pro-inflammatory cytokines and growth factors in human lung cells) in cultured mesothelial cells at 8 hr and no changes at 24 hr, whereas expression levels of 30 genes were elevated at 8 hr at high talc concentrations.

Tumor necrosis factor (TNF)- α is a cell signaling protein produced by macrophages, primarily involved in the regulation of immune cells. Pre-diagnostic serum levels of 46-inflammation –related biomarkers were measured in 149 incident ovarian cancer cases and matched controls. As has been discussed in several aforementioned sections of this Report, C-reactive protein (CRP), IL-1- α and TNF- α proved to all be significantly elevated and associated with increased cancer risk. In analyses restricted to serous ovarian cancer (n=83), the associations with CRP and IL-8 remained or strengthened. Thus, IL-8

can also be considered an inflammatory biomarker of ovarian cancer (Trabert et al., 2014), again demonstrating talc's action as an inflammatory agent. Iron and its homeostasis are intimately tied to the inflammatory response (Wessling-Resnik, 2010). Talc has been shown to modulate TNF- α and IL-6 production by its binding to iron (Ghio, 2011). TNF- α , like CRP, is a marker of various inflammation processes. TNF- α has been shown to play a role in later steps of carcinogenesis. For example, NF- κ B activation by TNF- α is involved in neoplastic transformation, proliferation, and tumor survival. In addition, in ovarian cancer cells, TNF- α enhances cell migration and metastasis through the action of NF- κ B. TNF- α was positively associated with ovarian cancer in case-control studies using serum samples collected at diagnosis.

C. Role of Oxidants in Ovarian Cancer

The chronic inflammatory states associated with infection and irritation may lead to environments that foster genomic lesions and tumor initiation. One effector mechanism by which the host system responds to insult is production of free radicals such as reactive oxygen species (ROS), hydroxyl radical (OH \bullet) and superoxide (O $_2$ - \bullet) and reactive nitrogen species (RNS), nitric oxide (NO \bullet) and peroxynitrite (ONOO). Primarily thought to be anti-microbial, these molecules form due to the activities of host enzymes such as myeloperoxidase, NADPH oxidase, and nitric oxide, which are regulated by inflammatory signaling pathways. Importantly, ROS and RNS lead to oxidative damage and nitration of DNA bases which increase the risk of DNA mutations.

During inflammation, macrophages, mast cells and neutrophils are recruited to the site of damage, which leads to a 'respiratory burst' due to an increased uptake of oxygen, and thus, an increased release and accumulation of ROS at the site of damage. A sustained inflammatory/oxidative environment leads to a vicious circle, which can damage healthy neighboring epithelial and stromal cells and over a long period of time may lead to carcinogenesis. Oxidative stress can also activate a variety of transcription factors. Activation of these transcription factors can lead to the expression of over 500 different genes, including those for growth factors, inflammatory cytokines, chemokines, cell cycle regulatory molecules, and anti-inflammatory molecules that can also be linked to cancer. Under a sustained environmental stress, ROS are produced over a long time, and thus significant damage may occur to cell structure and functions that could induce neoplastic transformation. In general, the longer the inflammation persists, the higher the risk of cancer.

Following an inflammatory stimulus, initiation of carcinogenesis mediated by ROS may be direct (oxidation, nitration, halogenation of nuclear DNA, RNA, and lipids), or mediated by the signaling pathways activated by ROS (Reuter, 2010; Saed, 2011; Saed, 2017). Hydrogen peroxide plays an important role in carcinogenesis because it is capable of diffusing through cell membranes and producing many types of cell injury. NO is another free radical implicated in carcinogenesis (Saed, 2017). iNOS, calcium-independent isoform, produces large amounts of NO and is only expressed during inflammation. ROS can specifically activate certain signaling pathways and thus contribute to tumor development through the regulation of cellular proliferation, angiogenesis, and metastasis.

1. Talc-Induced Inflammation and Oxidative Stress

Even a single dose of a carcinogen can produce effects that are adverse to cells and tissue at the site of exposure. *In vitro* studies provide a safe and effective vehicle by which to measure those effects in a controlled environment.

Carcinogenic potential of any compound can be determined by performing a well-established methodology called a neoplastic cell transformation assay. In a 2007 study by Buz'Zard, two human ovarian cell culture lines were treated in vitro with talc from 24 to 120 hr (Buz'Zard, 2007). Another group of talc-treated cells were also treated with a specific anti-inflammatory inhibitor to determine whether talc produced transformation through the production of inflammation. Following talc treatment of both ovarian cell types, the cells' ability to grow in suspension, a key characteristic of neoplastically transformed cells, was measured - non-neoplastically-transformed normal cells cannot grow in suspension. Results showed that treatment with talc can transform ovarian cells which further demonstrates the carcinogenic potential of talc. As anti-inflammatory treatment reduced formation of ROS and number of transformed colonies, a relationship between cell transformation and inflammation was demonstrated. Interestingly, exposure of ovarian cells to talc also increased ROS generation in this study in a time and dose-dependent manner. These effects could be linked with neoplastic changes as chronic inflammation is associated with cancer induction and ROS are often seen as a component of the tumor microenvironment. Human neutrophils exposed to talc in this study also increased ROS generation significantly compared to control phagocytes.

In a study carried out by Keskin in 2009, rats exposed to talc produced an increase in ovarian follicles which could be related to the "ovulation theory" associated with ovarian cancer, thus demonstrating a plausible mechanism for talcum powder-induced ovarian cancer.

Recent data demonstrates the importance of oxidative stress in ovarian cancer. The effects of talcum powder exposure on oxidative stress levels in normal ovarian epithelial cells, ovarian epithelial cells and cancerous ovarian epithelial cells were measured (Saed, 2017; Fletcher, 2018 (abstract)). Studies indicate that epithelial ovarian cancer manifests a persistent pro-oxidant state through alteration of the redox balance by the up-regulation of several oxidant enzymes in epithelial ovarian cancer tissues (Saed, 2018). Advancing similar work, in a recently accepted abstract, Harper and Saed report a mechanism by which talc enhances the pro-oxidant state in normal (ovarian and tubal) and ovarian cancer cells, through induction of gene point mutations (corresponding to known specific single nucleotide polymorphisms - SNPs) in key oxidant enzymes, altering their activities (Harper and Saed, 2018).

Emerging science by Fletcher (2018) demonstrated that talc-treated ovarian cancer cell lines and normal ovarian epithelial cells showed a marked increase in mRNA levels of pro-oxidant enzymes, including iNOS and MPO. This shift to a pro-oxidant environment indicates oxidative stress as early as 24 hours after exposure. These recent facts provide strong support for the ability of talc to produce an oxidant state that leads to inflammation and in turn epithelial ovarian cancer. This latter study shows that talcum powder enhances the redox state as part of the inflammatory cascade in both normal ovarian

epithelial cells and in ovarian cancer cells, revealing a plausible mechanistic underpinning for talc-induced ovarian cancer.

Another study by the same authors showed that talcum powder exposure increased levels of the cancer antigen, CA-125, in both normal ovarian cells and ovarian cancer cells. (Fletcher and Saed, 2018). CA-125 is an antigen that is elevated in some patients with specific types of cancers, and is used as a biomarker for ovarian cancer detection, providing further information about talcum powder's carcinogenic properties.

In a study by Shim et al. (2015), inhalation of talc revealed infiltration of macrophages and the increased expression of the antioxidant, superoxide dismutase indicating oxidative stress in rats. Moreover, in the same study inhalation of talc demonstrated macrophage aggregations and oxidative damage in the lungs. Intrapleural injection of talc particles produced an acute serum inflammatory response, more pronounced with smaller particles (Genofre et al., 2009). In addition, talc exposure induced vasoconstriction in the brain via the action of superoxide anions (Mori et al., 1995). Non-fibrous talc at low *in vitro* exposure concentrations caused increased expression of transcription factors associated with the inflammatory process in a time and dose-dependent manner (Shukla et al., 2009). Nano-talc exposure enhanced the production of pro-inflammatory cytokines by macrophages *in vitro* (Khan et al., 2011). Also, pre-treatment of macrophage (prior to talc exposure) with inflammatory signal transduction inhibitors reduced TNF mRNA stability demonstrating their role in TNF mRNA stabilization and expression (Khan et al., 2011).

In an epidemiological study, talc exposure was significantly associated with ovarian cancer in women who lacked a specific anti-oxidant genotype (glutathione-S transferase M1/T1) (Gates et al., 2008). Finally, talc exposure increases COX2, an enzyme that plays a critical role in inflammation (Pace et al., 2006).

At high concentrations or chronic exposure, ROS can damage cellular macromolecules and contribute to neoplastic transformation and/or tumor growth. Other likely manifestations of talc-induced inflammation include reduced fibrinolysis, activation of neutrophils and macrophages and increased production of cytokines and growth factors, and these have been suggested to occur in the peritoneum in response to contamination by surgical glove powder (Merritt et al., 2008).

In sum, inflammation is a primary mediator of ovarian cancer. As the scientific studies outlined above demonstrate, talcum powder products cause inflammation that can result in an elevation of biomarkers; changes in cell signaling; activation of chemokines and cytokines; changes in the oxidative environment; gene alterations and/or mutations; inhibition of apoptosis and induces neoplastic transformation and proliferation (i.e., cancer). This talcum powder-induced inflammatory cascade provides significant biologic and toxicologic support for a conclusion that talcum powder products can cause ovarian cancer.

D. Iron-Facilitated Inflammation

Talc particles can bind iron and iron facilitates inflammation and ROS production; surfaces of silicates including talc has a net negative charge on the surface which generates a capacity for the adsorption and exchange of cations like iron which has a high affinity for oxygen-donor ligands. According to J&J documents from Luzenac America Technical Center, heavy metal analyses on Grade 66 Non-Shear Disk Test Run samples demonstrated very high levels of iron (15,200 – 21,500 mg/kg) that could cause oxidative stress and an inflammatory response. Multiple studies have demonstrated that exposure to talc disrupts iron homeostasis, oxidative stress, and causes a fibro-inflammatory response (Akhtar et al., 2010; Ghio et al., 1992; Ghio et al., 2012). Talc exposure significantly increases iron importation and concentrations of ferritin (iron storage protein). The accumulation of iron, the accompanying oxidative stress, and inflammatory events after exposure to talc are comparable to those with other forms of particulate matter. The capacity of talc particles to support the *in vitro* generation of oxidants in an acellular environment was significantly affected by the concentration of associated iron, with talc-Fe producing a significantly greater signal for lipid peroxidation relative to talc alone (Akhtar, 2010). This relationship is supported by inhibition of the effect by addition of a metal chelator and a hydroxyl radical scavenger. The disruption of cell iron homeostasis is frequently associated with oxidative stress and inflammation.

IX. SUMMARY OF OPINIONS

I hold the following opinions to a reasonable degree of scientific certainty:

1. Based on the scientific literature and the testing results that I have seen by Defendants and Drs. Longo and Rigler, it is my opinion that talcum powder products, including Johnson's Baby Powder and Shower to Shower, may contain known carcinogens, including asbestos, fibrous talc, and heavy metals. In addition, these products contain fragrance chemicals, many of which are inflammatory agents, toxicants, or potential carcinogens.
2. Talcum powder can reach the ovaries through two routes with anticipated use: 1) perineal application (dermal) with migration/transport through the genital tract via the vagina, uterus, and fallopian tubes; and, 2) inhalation of talcum powder particles. Through either route, talcum powder and its constituents could reach the lymphatic system and bloodstream.
3. Exposure to talcum powder products causes an inflammatory tissue reaction which may result in the following:
 - a. Elevation of increased inflammatory markers;
 - b. Changes in cell signaling;
 - c. Activation and/or release of chemokines and cytokines;
 - d. Changes in the oxidative environment;
 - e. Gene alterations and/or mutations;
 - f. Inhibition of apoptosis; and

- g. Neoplastic transformation and proliferation
4. Based on knowledge of the carcinogenic components of talcum powder products, the potential of the powder, with its components, to reach the ovaries and the resultant inflammatory tissue response, it is biologically plausible for talcum powder products to cause ovarian cancer.

I reserve the right to amend or modify this report as new information becomes available. I have not testified in litigation over the previous 4 years. I am charging \$ 350 per hour for my work on this matter.

Exhibit A

JUDITH TERRY ZELIKOFF, Ph.D.
Tenured Professor

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EDUCATION

- 1973:** Bachelor of Science (**Biology**)
Upsala College
East Orange, NJ
- 1976:** Master of Science (**Microbiology**)
Farleigh Dickinson University
Department of Biology
Teaneck, NJ,
in conjunction with,
UMDNJ-New Jersey Medical School
Department of Neuroscience
Newark, NJ
Thesis Dissertation: Herpes Simplex Virus-IgM Specific Antibodies in
Guillian-Barre Syndrome
- 1982:** Doctor of Philosophy (**Experimental Pathology**)
UMDNJ-New Jersey Medical School
Department of Pathology
Newark, NJ
Thesis Dissertation: Cytoskeletal Modifications of Human Fibroblasts
that Occur During a Complement-Dependent Cytotoxic Antibody
Response

PROFESSIONAL EXPERIENCE

1982-Present: **NEW YORK UNIVERSITY SCHOOL OF MEDICINE**
Institute of Environmental Medicine
Tuxedo, NY

2005- Present: Tenured Professor
Laboratory of Pulmonary & Systemic Toxicology

Developmental Immunotoxicology: Effects of fetal insults on later life
immune-related diseases in the offspring.

Pulmonary Immunotoxicology: Characterization of inhaled metal, gaseous,
and airborne pollutant mixtures including woodsmoke and tobacco smoke,
on pulmonary immune defense mechanisms and host resistance against
infectious disease and asthma.

Environmental Toxicology/Ecoimmunotoxicology: Effects of aquatic pollutants on the immune responses of fish; development of immune biomarkers. Alternate animal models for immunotoxicological studies.

1995-2005: Associate Professor (Tenured in 1997)

Laboratory of Systemic Toxicology

1989-1995: Assistant Professor

1986-1989: Research Assistant Professor

Laboratory of Pulmonary Biology

Laboratory of Environmental Toxicology

Environmental Toxicology: Characterization of aquatic pollutants and immune defense mechanisms of fish. Studies concerning drug bioaccumulation and metabolism in different fish species.

Inhalation/Pulmonary Toxicology: Effects of ambient pollutants on macrophage metabolism and immune function.

1984-1986: Associate Research Scientist

Laboratory of Environmental Toxicology

Genetic Toxicology: Clastogenic/mutagenic effects of complex environmental mixtures.

Cell Biology: Establishment of primary cultures for assessing the toxicity of environmental contaminants *in vitro*.

1982-1984: NIH (NHLBI) Post-Doctoral Fellow

Laboratory of Environmental Toxicology

Genetic Toxicology: Development of short-term *in vitro* bioassays to detect carcinogens, promoters and co-carcinogens in complex environmental mixtures.

1977-1978: PFIZER PHARMACEUTICAL

Laboratory of Chemical Carcinogenesis

Maywood, NJ

Assistant Research Scientist

Laboratory studies using animal models and *in vitro* mammalian cell systems to investigate chemical- and viral-induced carcinogenesis.

1974-1975: VA HOSPITAL /UMDNJ-NEW JERSEY MEDICAL SCHOOL

Department of Neuroimmunology

East Orange, NJ

Associate Research Scientist

Laboratory studies investigating the etiology of viral-induced neuropathologies

TEACHING EXPERIENCE - NATIONAL

1990-Present: *NEW YORK UNIVERSITY SCHOOL OF MEDICINE*

Department of Environmental Medicine

Tuxedo, NY

Graduate Courses

- Global toxicology & community health (NYU Global College of Public Health: Organizer/Director, Fall, 2018; offered every year)
- Environmental Immunotoxicology (Organizer/Director, 1993-present)
- Organ System Toxicology (Director, 2001-present)
- Toxicology (Biology-cross linked: Director, 2010 – present)
- Communication Skills (Lecturer; 2010-present)
- Principles of Toxicology (Lecturer; 1992-present)
- Environmental Physiology of the Respiratory Tract (Lecturer; 1992– 1994)

1979-1994: *WILLIAM PATERSON COLLEGE*

Department of Biology

Wayne, NJ

Adjunct Professor

Undergraduate Courses

- Microbiology lecture and laboratory (1979 - 1984)
- Human biology lecture and laboratory (1979 - 1994)

1991-1994: *ROCKLAND COMMUNITY COLLEGE*

Department of Biology

Suffern, NY

Adjunct Professor

Undergraduate Courses

- Microbiology lecture and laboratory

1979-1982: *SETON HALL UNIVERSITY*

Department of Biology

South Orange, NJ

Research Scientist/Graduate Assistant

-Laboratory studies in immunopathology, virology, viral immunology, and microbiology

- Undergraduate and Graduate Courses

- Bacteriology lecture and laboratory
- Advanced Microbiology
- Cell biology/Virology techniques

1976-1979: *FAIRLEIGH DICKINSON UNIVERSITY*

Department of Biology

Teaneck, NJ

Adjunct Professor

Undergraduate and Graduate Courses

- General biology lecture and laboratory

- Human genetics
- Immunology

TEACHING EXPERIENCE - INTERNATIONAL

2013-present *UNIVERSITY OF PORT HARCOURT (Port Harcourt, Nigeria)*

Dept. of Toxicology

Lecturer in graduate toxicology course

2002-present: *CHULABHORN RESEARCH & GRADUATE INSTITUTE (Professor, Course Director)*

Department of Toxicology

Bangkok, Thailand

Graduate Course (3 weeks- given every even year)

- Environmental Immunotoxicology and Reprotoxicology

1999

1999-2000: *UNIVERSITY OF TASMANIA (Adjunct Professor)*

Department of Environmental Toxicology

Tasmania, Australia

Graduate Course (2 weeks)

- Fish Immunology & Immunotoxicology (Organizer/Director; Lecture and Lab)

1999-2000: *LINCOLN UNIVERSITY*

Department of Environmental Health Sciences

Christ Church, New Zealand

Graduate Course (2 weeks)

- Fish Immunology & Immunotoxicology (Organizer/Director; Lecture and Lab)

HONORS AND AWARDS

- 2018 – Society of Toxicology (SOT), Education Award
- 2015 – SOT, Women in Toxicology Mentorship Award
- 2013 – West African SOT (WASOT), Distinguished Recognition
- 2012 - 2014, SOT, Distinguished Service as SOT Secretary
- 2012 - SOT, Global Senior Scholar Host Award
- 2012 – SOT, Career Achievement Award in Immunotoxicology
- 2008 – Mid-Atlantic Chapter Society of Toxicology, President

PUBLICATIONS

Peer-reviewed Journals (In ascending order)

1. Ende, N., E.V. Orsi, F. Buechel, N.Z. Baturay and **J.T. Zelikoff**. Antibodies to synovial derived cells in patients undergoing artificial prosthesis transplants. *J. Orthopedic Res.* 3: 78-83 (1985).
2. **Zelikoff, J.T.**, J.M. Daisey, K. Traul and T.J. Kneip. Balb/c 3T3 cell transformation response to organic extracts of airborne particulate matter as seen by their survival in aggregate form. *Mutat. Res.* 144: 107-116 (1985).
3. **Zelikoff, J.T.**, N. Atkins, T.G. Rossman and J.M. Daisey. Cytotoxicity of fine particles with and without absorbed polycyclic aromatic hydrocarbons using Chinese hamster lung cells (V79). *Environ. Internat.* 11: 331-339 (1985).

4. **Zelikoff, J.T.**, N. Atkins and S. Belman. Stimulation of cell growth and proliferation in NIH-3T3 cells using onion and garlic oil. *Cell Biol. Toxicol.* 2: 369-378 (1986).
5. Ende, J., J. Grizzanti, E.V. Orsi, P.P. Lubanski, R.C. Amarusso, L.B. Reichman and **J.T. Zelikoff**. Sarcoid and cytotoxic lung antibodies. *Life Sciences* 39: 2435-2440 (1986).
6. Rossman, T.G., **J.T. Zelikoff**, S. Agarwal and T.J. Kneip. Genetic toxicology of metal compounds: An examination of appropriate cellular models. *Toxicol. Environ. Chem.* 14: 251-262 (1987).
7. Squibb, K.S., C.M.F. Michel, **J.T. Zelikoff** and J.M. O'Connor. Kinetics and metabolism in the channel catfish *Ictalurus punctatus*. *Veterinary Human Toxicol.* 34: 620 (1988).
8. **Zelikoff, J.T.**, J.H. Li, A. Hartwig and T.G. Rossman. Genetic toxicology of lead compounds. *Carcinogenesis* 9: 1727-1732 (1988).
9. Schlesinger, R.B., A.F. Gunnison and **J.T. Zelikoff**. Modulation of pulmonary eicosanoid biosynthesis following exposure to sulfuric acid. *Fundam. Appl. Toxicol.* 15: 151-162 (1990).
10. Schlesinger, R.B., K.E. Driscoll, A.F. Gunnison and **J.T. Zelikoff**. Pulmonary arachadonic acid metabolism following acute exposures to ozone and nitrogen dioxide. *J. Toxicol. Environ. Health* 31: 275-290 (1990).
11. Schlesinger, R.B., L.C. Chen and **J.T. Zelikoff**. Comparative potency of inhaled acidic sulfate aerosols: The influence of specific components and the role of H⁺ ions. *Environ. Res.* 52: 210-224 (1990).
12. Schlesinger, R.B., P.A. Weideman and **J.T. Zelikoff**. Effects of repeated exposure to ozone on respiratory tract prostanoids. *Inhal. Toxicol.* 3: 27-36 (1991).
13. **Zelikoff, J.T.**, N.A. Enane, D. Bowser, K.S. Squibb and K. Frenkel. Development of fish peritoneal macrophages as a model for higher vertebrates in immunotoxicological studies. I. Characterization of trout macrophage morphological, functional and biochemical properties. *Fundam. Appl. Toxicol.* 16: 576-589 (1991).
14. **Zelikoff, J.T.**, G.L. Creamer, M.C. Vogel and R.B. Schlesinger. Immunomodulating effects of ozone on macrophage functions important for tumor surveillance and host defense of the lung. *J. Toxicol. Environ. Health* 34: 449-467 (1991).
15. Costa, M., N.T. Christie, O. Cantoni, **J.T. Zelikoff**, X.W. Wang and T.G. Rossman. DNA damage by mercury compounds: An overview. Proc. of Advances for Mercury Toxicology. In *Advances in Mercury Toxicology* (T. Suzuki, Ed.), Plenum Press, NY. pp. 255-273 (1991).

16. Schlesinger, R.B., **J.T. Zelikoff**, L.C. Chen and P.L. Kinney. Assessment of toxicologic interactions resulting from acute inhalation exposure to sulfuric acid and ozone mixtures. *Toxicol. Appl. Pharmacol.* 115(2): 183-190 (1992).
17. **Zelikoff, J.T.** and R.B. Schlesinger. Immunomodulation by sulfuric acid aerosol: Effects on pulmonary macrophage-derived tumor necrosis factor and superoxide production. *Toxicology* 76: 271-281 (1992).
18. Cohen, M.D., E. Parsons, R.B. Schlesinger and **J.T. Zelikoff**. Immunotoxicity of *in vitro* vanadium exposure: Effects on interleukin-1, tumor necrosis factor, and prostaglandin E2 production by macrophages. *Int. J. Immunopharmacol. Immunotoxicol.* 15: 437-446 (1993).
19. **Zelikoff, J.T.** Metal pollution-induced immunomodulation in fish. *Ann. Rev. Fish Dis.* 2: 305-325 (1993).
20. **Zelikoff, J.T.**, E. Parsons and R.B. Schlesinger. Immunomodulating activity of inhaled particulate lead oxide disrupts pulmonary macrophage-mediated functions important for host defense and tumor surveillance in the lung. *Environ. Res.* 62: 207-222 (1993).
21. Enane, N.A., K. Frenkel, J.M. O'Connor, K.S. Squibb and **J.T. Zelikoff**. Fish macrophages as an alternative model for mammalian phagocytes. *Immunol.*, 80: 68-72 (1993).
22. **Zelikoff, J.T.**, R. Smialowicz, P.E. Bigazzi, R.A. Goyer, D.A. Lawrence, H.I. Maibach and D. Gardner. Immunomodulation by metals. *Fund. Appl. Toxicol.* 22: 1-8 (1994).
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24. Schlesinger, R.B., H. El-Fawal, **J.T. Zelikoff**, J.E. Gorczynski, T. McGovern, C.E. Nadziejko, and L.C. Chen. Pulmonary effects of repeated episodic exposures to nitric acid vapor alone and in combination with ozone. *Inhal. Toxicol.* 6: 21-41 (1994).
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28. **Zelikoff, J.T.**, K. Squibb, D. Bowser and K. Frenkel. Immunotoxicity of low level cadmium exposure in fish: Alternative animal models for immunotoxicological studies. *J. Toxicol. Environ Health* 45:235-248 (1995).

29. Cohen, M.D., T.P. McManus, Z. Yang, Q. Qu, R.B. Schlesinger, and **J.T. Zelikoff**. Vanadium alters macrophage interferon-gamma interactions and interferon-inducible responses. *Toxicol. Appl. Pharmacol.* 138: 110-120 (1996).
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32. Cohen, M.D., S. Becker, R. Devlin, R.B. Schlesinger, and **J.T. Zelikoff**. Effects of vanadium upon polyI:C-induced responses in rat lung and alveolar macrophage. *J. Toxicol. Environ. Health* 51: 591-608 (1997).
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18. **Zelikoff, J.T.**, E. Carlson, E., Y. Li, A. Raymond, and J.R. Beaman. 2002. Immune system biomarkers in fish for predicting the effects of environmental pollution. In: *Proceedings of the Fourth Princess Chulabhorn International Science Congress*.

Chemicals in the 21st Century/Chemicals for Sustainable Development. (Chulabhorn Research Institute, Ed.), Trinity Publishing Co., Ltd., Bangkok, THAILAND, pp. 34-56.

19. Duffy, J., and J.T. Zelikoff. 2005. Approaches and models for the assessment of chemical-induced immunotoxicity in fish. In: *Investigative Immunotoxicology*. (H. Tryphonas, M. Fournier, B.R. Blakley, J.E. Smits, P. Brousseau, Eds.), Taylor and Francis, NY. pp. 49-63.

20. Zelikoff, J.T. 2005. Trace metals and the immune system. In: *Encyclopedic Reference of Immunotoxicology*. (H.W. Vorh). Springer-Verlag, Germany pp. 340-345.

21. Carlson, E. and J.T. Zelikoff. 2008. Fish immunology. In: *Toxicology of Fishes* (D. Hinton and R. Di Giulio, Eds.), CRC Press. pp. 340-352.

22. Ramanathan VM., Agrawal M., Akimoto H., Aufhammer S., (and 34 others), Zelikoff JT. UNEP: Atmospheric Brown Cloud: A Regional Assessment Report with Focus on Asia. Published in Bangkok by United Nations Environmental Program (2008).

23. Ng, SP., K. Yoshido, and J.T. Zelikoff. 2010. Host resistance tumor challenge assays. In: *Techniques in Immunotoxicology* (R. Dietert, Ed.) Informa Press.

24. Zelikoff, J.T. 2010. Other environmental health issues: Inhaled woodsmoke. In: *Encyclopedia of Environmental Health*. J. Nriagu (Ed.). Elsevier, UK. Pages 310-330.

25. Mudipalli, A. and Zelikoff, J.T. (Eds). Essential and non-essential metals: carcinogenesis, prevention and therapeutics. Springer, UK. 2018.

26. Ng, S.P., Zelikoff J.T. Tumor challenges in immunotoxicity testing. Vol. 599. Humana Press, Springer Science. Immunotoxicity Testing: Methods and Protocols, Methods in Molecular Biology. (2018)

27. Zelikoff, J.T., and M.D. Cohen. Pulmonary Immunology. In: *Comprehensive Toxicology*. (C. McQueen, Ed.). Elsevier, UK. 2018.

INVITED NATIONAL AND INTERNATIONAL LECTURES/PRESENTATIONS (Present – 2000, in descending order):

August 2018: International Society of Exposure Science (ISES); International Society for Environmental Exposure (ISEE). *Contamination of the Ramapough Nation: A toxic legacy. Environmental contamination and Indigenous populations symposia.* Ontario, Canada.

February 2018: Louisiana State University. Electronic cigarettes and pregnancy: Lessons learned from mice. Baton Rouge, LA

January 2018: Mt. Holyoke College. What's safer for the unborn child: electronic cigarettes or air pollution? MA.

December 2017: Texas A & M. Prenatal exposure to ambient particulate matter impacts cardiovascular development. TX.

December 2017: International Conference on Environmental Impacts. Air pollution and pregnancy. Deradun, India

November 2017: International Conference on "Impact of Environment on Women's Health: Amity University Uttar Pradesh. Maternal exposure to particulate air pollution during pregnancy and Impacts on fetal health: What are we learning from animal studies? Lucknow, India.

November 2017: American Public Health Assoc. (APHA) Annual Meeting. Identifying Environmental concerns, environmental exposures and health concerns in the Ramapough Lenape Tribe. Atlanta, GA.

October 2017: International Society of Exposure Science. A community in toxic crisis: Ramapough Native Americans. Durham, NC.

- April 2017: Queensborough College.** Neurocognitive effects of E-cigarettes. Queens, NY.
- July 2016: NIOSH seminar.** Reproductive implications of Nanomaterials. WV
- July 2016: EPA seminar.** Ambient particulate matter and cardiotoxicity. Chapel Hill, NC.
- June 2016: Workshop on Nanomaterials and the fetal-placental unit.** Prenatal Nephrotoxicity and Maternal Nanomaterial Inhalation. Boston, MA.
- May 2016: NIH Tobacco Research.** Toxicological assessment of smokeless tobacco products: A systematic ranking system. Bethesda, MD
- April 2016: AHA, ATrac Meeting.** Toxicity ranking of alternative tobacco products. Louisville, KY.
- March 2016: Society of Toxicology: Course in Medical Education.** Effects of fracking on reproductive and developmental health. New Orleans, LA
- March 2016: Society of Toxicology: Symposia on Fracking and Health.** Effects of fracking on reproductive and developmental health. New Orleans, LA
- February 2016: American Association for Advancement of Science: Symposia on Alternative Tobacco Products and Health.** Early life exposure to alternative tobacco products as a major risk factor of later life chronic disease. Washington, DC
- October 2015: 7th International Symposia on Nanotechnology and Occupational and Environmental Health.** Reproductive and developmental toxicity of gold nanoparticles in a mouse model of pulmonary exposure. Limpopo Province, South Africa.
- May 2015: Amer. Assoc. Immunol.** Maternal inhalation of ambient particulate matter causes alterations in immune profiles and anti-tumor mechanisms in juvenile murine offspring. New Orleans, LA.
- April 2015: Wayne State University, CURES Seminar Series at Wayne State University's Institute of Environmental Health Sciences.** Maternal exposure to particulate air pollution during pregnancy impacts fetal development and neonatal growth in a mouse model.
- March 2015: Society of Toxicology.** Symposia on: New and Emerging Tobacco Products—Biomarkers of Exposure and Injury (Chair). Reproductive/Developmental effects of exposure to new and emerging tobacco products and to nicotine delivery devices in a mouse model. San Diego, CA.
- Dec. 2014: University of Illinois –** Maternal exposure to ambient particulate matter during particular gestational windows produce developmental and reproductive consequences in a mouse model. Urbane, IL.
- July 2014: Oregon State University –** Early life nanoparticle exposure brings early and later life health consequences. Corvallis, OR.
- March 2014: Society of Toxicology –** Tobacco products and prenatal exposures. Phoenix, Arizona.
- February 2014: West African Society of Toxicology –** Air pollution in developing nations. Lagos, Nigeria.
- January 2014: Ernst Strungmann (ES) Forum, (Rapporteur)-** Heavy metals and infectious disease. Frankfurt Germany.
- November 2013: American Chemical Council.** Risk Assessment and Communication, Working Group. Washington, DC.
- October 2013: First International Conference on Waterpipe Tobacco Research.** Working Discussion Group Leader: Abu Dhabi.
- October 2013: NIH-sponsored Workshop in South Asian Diversity Populations and Health Effects.** Sloan Kettering Cancer Center. Working Group member on smokeless tobacco. NY, NY.

- June 2013: FDA, Center for Tobacco Control.** Public health impacts of fetal exposures to tobacco & environmental toxicants: From early life to adult disease and policy needs. MD
- March 2013: Society of Toxicology, Committee on Diversity Initiatives** – Exposure to smoked and smokeless tobacco *in utero*: Fetal injury and life long consequences. San Antonio, TX
- February 2013: Nigeria University** – Smokeless tobacco: A global look at the problem, Port Harcourt, NIGERIA
- February 2013: FDA: Center for Medical Devices** – Fetal basis of adult disease: early life exposure to environmental and occupational toxicants. Silver Spring, MD.
- October 2012: Memorial Sloan Kettering** – Arsenic contamination in Bangladesh. New York, NY
- May 2012: Memorial Sloan Kettering** – Toxicology of Smokeless tobacco. NY, NY.
- April 2012: University of Connecticut** – Tobacco products *in utero* are associated with later life disease outcomes. Storrs, CT.
- March 2012: Biomass Symposium** – Toxicological implications for domestic burning. Feb. 2012: NYU Medical Center, Dept. of Psychiatry - Chemical stressors *in utero* and later life disease outcomes. New York, NY.
- Jan 2012: British American Tobacco** – *In vitro* translational studies and the toxicology of smoking. Southampton, UK.
- Dec. 2011: FDA** – **The reproductive effects of cadmium nanoparticles.** Reston, VA.
- Dec. 2011: NYU Dept. of Bioethics** – Cigarette smoking & smokeless tobacco: Is there really a good choice? New York
- Oct. 2011: NorCal SOT** – **Fetal basis of adult disease – the role of maternal smoking.** Menlo Park, CA.
- Sept. 2011: European Aerosol Conference – Plenary Lecture:** The toxicology of biomass combustion emissions. Satellite Workshop on Biomass Combustion, Manchester, England.
- March 2011: NYU Ethics Forum** - Exposure to Cigarette Smoke *in Utero*: Fetal injury and Life Long Consequences. New York
- March 2011: NYU Medical Center, Dept. of Obstetrics and Gynecology Grand Rounds** – Early life insult by tobacco smoke and later life disease susceptibilities. March 15, 2011
- March 2011: Society of Toxicology, Committee for Diversity Interests** – Cigarette exposure *in utero*: You are what you breathe. Washington, DC. March, 2011.
- Nov. 2010: Texas A & M University** – Early life exposure to cigarette smoke suppresses anti-tumor immune defenses of the prenatally exposed offspring in a mouse model” College Station, TX.
- May 2010: Workshop on Emissions and Health Impacts of Biomass Fuels** – Health effects of woodsmoke: A toxicological model for mechanisms and policy needs. Penn State, State College, PA.
- March 2010: Environmental and Occupational Health Sciences Institute, Rutgers University** - Fetal exposure to cigarette smoke mediates anti-tumor immune mechanisms in adult murine offspring. New Brunswick, NJ. March, 2010.
- March 2010: Society of Toxicology, Committee for Diversity Interests** – Exposure to cigarette smoke *in utero*: Fetal injury and life-long consequences. Salt Lake City, UT.
- Nov. 2009: United Nations Environmental Programme** – Toxicological assessment of the atmospheric brown cloud. Incheon, Korea.
- Sept. 2009: 7th Congress of Toxicology in Developing Countries** – Fetal insult and later onset diseases. Sun City, South Africa.

- August 2009: *Japanese Society of Immunotoxicology*** – Prenatal exposure to cigarette smoke increases tumor susceptibility of juvenile mice via changes in anti-tumor immune mechanisms. Asahikawa, Japan.
- May 2009: *Asia-Pacific Forum on Andrology***, Hormonal changes accompanying cigarette smoke induced preterm births in a mouse model. Nanjing China.
- Dec. 2008: *St. Johns University*** – Mechanistic insights into offspring cancer risk associated with maternal smoking. Queens, NY.
- August 2008: *U.S. EPA, National Center for Environmental Assessment*** - Gender-related effects on offspring tumor risk and response to prenatal cigarette smoke exposure may be related to testosterone: a toxicological model. Washington, DC.
- June 2008: *Institute for Science and Health (IFSH)*** – Early exposure to cigarette smoke may serve as an indicator of chronic diseases in the offspring later in life. Cardiff, Wales.
- March 2008: *Society of Toxicology*** –Prenatal exposure to tobacco smoke induces asthma-related responses in non-sensitized female offspring later in life. Seattle, Washington.
- March 2008: *Society of Toxicology*** – Prenatal exposure to cigarette smoke: Are our children paying the price? Seattle, Washington. March 2008.
- August 2007: *United Nations Environmental Program (UNEP)*** – Toxicology of the Atmospheric Brown Cloud (ABC). Seoul, Korea.
- March 2007: *University of Louisville (KY)*** – Increased cancer risk: A possible birth defect associated with maternal smoking. Louisville, KY.
- March 2007: *Institute for Science and Health (IFSH)*** – Prenatal cigarette smoke exposure and offspring asthma. Louisville, KY.
- Feb. 2007: *International Conference on Environment: Survival and Sustainability*** - Sustaining a healthy fetal environment: A little told threat of increased cancer and asthma risk for the juvenile offspring exposed prenatally to cigarette Smoke. Near East University, Nicosia-Northern Cyprus.
- Feb. 2007: *International Conference on Environment: Survival and Sustainability*** - Contamination of aquatic environments with polychlorinated biphenyls (PCBs) or benzo(a)pyrene (B[a]P) can adversely impact the immune health and sustainability of inhabiting Fish. Near East University, Nicosia-Northern Cyprus.
- Dec. 2006: *Philip Morris External Review Symposia*** – Effects of prenatal exposure to cigarette smoke on tumor development and immune surveillance mechanisms in the developing offspring: A toxicological model. Landsdowne, VA. Dec. 2006.
- May 2006: *MidAtlantic Chapter of Society of Toxicology (MASOT)*** – Increased cancer risk in the offspring: A birth defect associated with maternal smoking. Scotch Plains, NJ.
- April 2006: *University of Guelph*** – Maternal smoking and cancer: Are the unborn children paying the price? Kempville, Ontario Canada.
- March 2006: *Institute for Science and Health*** – Prenatal exposure to mainstream cigarette smoke alters susceptibility of the offspring to asthma. Vienna, Austria.
- March 2006: *Society of Toxicology*** – Maternal smoking and cancer: Are the unborn children paying the price? San Diego, CA.
- October 2005: *Chulabhorn Research Institute*** – *Immunotoxicology: A new focus for Thai science*. Scientific Research Institute of Thailand. Bangkok, Thailand.
- May 2005: *American Thoracic Society*** - Immunotoxicological mechanisms of prenatally-exposed respiratory contaminants. Symposia on “Impact of prenatal and early infancy environmental exposures on neonatal and infant health”. San Diego, CA..

- May 2005: *California Society of Environmental Toxicology and Chemistry*** – Mechanisms of Fish Immunotoxicity. Berkley, CA.
- April 2005: *Life Science Research Organization (LSRO)*** – Prenatal exposure to cigarette smoke increases tumor susceptibility in the offspring: A toxicological model. St. Louis, MO.
- March 2005 - *Society of Toxicology*** – Immunotoxicity of prenatal mainstream cigarette smoke exposure. Symposia on “Mechanisms Linking the Lung and Immune System”. New Orleans, LA.
- Feb. 2005: *Institute for Science and Health (IFSH)*** – Effects of in utero cigarette smoke exposure on asthma development in the offspring. Washington, DC.
- Feb. 2005: *Canadian Lung Association*** – Health Effects of Woodburning. New Brunswick, Canada.
- Nov. 2004: *Environmental Mercury Research Forum***. Metal toxicity in aquatic organisms. Energy & Environmental Research Center (U. of North Dakota). Grand Forks, ND.
- Oct. 2004: *VIIIth Annual Conference of Soil, Sediments and Water***. Immunological Alterations as Bioindicators of Environmental Health. Amherst, MA.
- Sept. 2004: *Slovenian Society of Toxicology*** – Immunological biomarkers. Lubljana, Slovenia.
- March 2004: *Society of Toxicology*** – Inhalation of concentrated ambient particulate matter and associated metals increases host susceptibility to pulmonary pneumonia. Baltimore, MD.
- Jan. 2004: *University of Arizona*** – Toxicological impact of inhaled wood smoke on pulmonary antimicrobial defense. Tucson, AZ.
- Jan. 2004: *College of Staten Island*** – Toxic insult and human health effects: Lessons learned from an aquatic species. Staten Island, NY.
- Dec. 2003: *Sixth National Environmental Public Health Conference (Center for Disease Control)*** Woodsmoke: A closer look at public health concerns and mechanisms of toxicity. Atlanta, GA.
- Nov. 2003: *Society of Environmental Toxicology and Chemistry*** - Immunotoxicology and Risk Assessment. Austin, TX.
- Oct. 2003: *Chulabhorn Research Institute*** – Immunotoxicology Course Series (10d). Bangkok, Thailand.
- June 2003: *International Symposium on Pharmaceutical Sciences*** - Health Effects of Inhaled Particulates. University of Pharmaceutical Sciences. Ankara, Turkey.
- June 2003: *United States Army Center for Environmental Health Research*** - Immune Assays for Hazard Assessment and Species Extrapolation. Fort Detrick, MD.
- May 2003 - *Pollutant Responses of Marine Organisms (PRIMO)*** - Immunotoxicology in Fish. Tampa, FL.
- March 2003: *Society of Toxicology*** - Woodsmoke: Cozy Atmosphere or Public Menace? Salt Lake City, UT.
- Nov. 2002: *Society of Toxicology and Chemistry*** - Immune Biomarkers for Use in Ecological Risk Assessment. Salt Lake City, UT.
- Oct. 2002: *Padova University*** - Lessons Learned About Human Health From Aquatic Species. Padova, Italy.
- Oct. 2002 - *Slovenia Society of Toxicology*** - Biomarkers for Ecotoxicology. Ljubljana, Slovenia.
- Sept. 2002: *University of Florida*** - Effects and Mechanisms of Benzo(a)pyrene-induced Immunosuppression in Fish. Gainesville, FL.

June 2002: Yale University, Dept. of Occupational and Environmental Medicine -
Lessons on Human Health and Toxic Impact Learned from our Aquatic
Counterparts.

**Sept. 2001: Third International Meeting on Molecular Mechanisms of Metal
Toxicity and Carcinogenicity -** Immunodysfunction: An underlying Mechanism of
Metal Toxicity in Aquatic Organisms. Sardinia, Italy.

July 2001: Pollutant Responses in Marine Organisms - Immunotoxicology in fish -
Applications and Mechanisms of Response. Plymouth, England.

Oct. 2000: Conference on Women in Science - Aging: Good or Bad News for the
Immune Response. Rutgers University. New Brunswick, NJ.

**Oct. 2000: International Conference on Environmental and Occupational Lung
Disease -** Woodsmoke Impairs Host Resistance Against Pulmonary Infections in an
Animal Model. Lucknow, India.

May 2000: EPA-Duluth - Fish Immune Status: A Sensitive System for Assessing
Toxicological Impact of Aquatic Environments. Duluth, MN.

May 2000: University of Minnesota-Duluth - Processes and Mechanisms of
Woodsmoke-induced Immunosuppression. Duluth, MN.

March 2000: International Symposia on Medaka - Japanese Medaka: A Sensitive
Teleost Model for Assessing the Immunotoxic Effects of Potential Endocrine-
Disrupting Chemicals. Osaka, Japan.

Nov. 2000: The Fourth Princess Chulabhorn Science Congress- Immune System
Biomarkers for Predicting the Effects of Environmental Pollution. Bangkok, Thailand.

EDITOR/EDITORIAL BOARD APPOINTMENTS

Editor and Co-Editor:

Metal Toxicology, Co-Editor (Springer Publ.) – (2016)

Pulmonary Immunotoxicology (Klewar Publ.) - (2000)

Immunotoxicology of Occupational and Environmental Metals. (Taylor and Francis) -
(1998)

Ecotoxicology: Responses, Biomarkers and Risk Assessment. (SOS Publications) -
(1997)

Modulators of Immune Responses: A Phylogenetic Approach - Vol. 2 (SOS
Publications)-(1996)

Modulators of Immune Responses - Vol. 1 (SOS Publications) - (1994)

Toxicology and Ecotoxicology News (Taylor & Francis) - (1995-1998)

Book series on: Ecotoxicology (John Wiley & Sons) - (1995-1997)

Associate Editor-

Open Journal of Immunology (2015-2018)

Journal of Developmental Origins of Health & Disease (2012-2013; Themed Editor)

Journal of Toxicology and Applied Pharmacology – (2005-2014)

Journal of Toxicology and Environmental Health - Part A - (2001 - Present)

Biomarkers: Exposure, Effects and Susceptibility - (1995 – 2007)

Editorial Advisory Board-

Environmental Health Perspectives (2017-2020)

Open Journal of Toxicology (2015-present)

Inhalation Toxicology (2015-present)

Open Journal on Immunology (2009-present)

Journal of Immunotoxicology (2004 - 2016)

Toxicol. Sci. (2007-2016)
Toxicology (1997- 2016)
Environmental Health Perspectives (2009 – 2013; named a top reviewer for 2011)
Environmental Bioindicators (2005- 2011)
Inhalation Toxicology (2004 – 2008; 2013-2016)
Fish and Shellfish Immunology (1997 - 2008)
Toxicology Applied Pharmacology (1996 - 2005)
Diseases of Aquatic Organisms (1995 - 2006)
Aquatic Toxicology (1998 - 2006)
Journal of Toxicology and Environmental Health (1996 - 2001)
Fish Immunology Technical Communications- Vols. 2-5 (1994 - 1997)

CHAired SESSIONS/MEETING ORGANIZER (1997 – present, descending order)

Outside University

- Organizer/Instructor of International Student & Faculty Workshop on "Fish Immunology" (Tasmania, Australia; February 1997)
- Organizer/Instructor of Student & Faculty Mini-workshop on "Fish Immunology" (Christ Church, New Zealand; February 1997)
- Chairperson at International Meeting on "Developmental and Comparative Immunology" (Williamsburg VA; July 1997)
- Organizer of Student & Faculty International Workshop on "Fish Immunotoxicology Techniques" (American College, Madurai India; February 1999).
- Organizer of Continuing Education Course on "Exposure Assessment: Methods and Applications" at Aquatic Toxicity Workshop Meeting (Edmonton, Canada; October 1999).
- Chairperson of Symposium on "Profiling Immunotoxicology" at Aquatic Toxicity Workshop Meeting (Edmonton, Canada; October 1999).
- International Conference on Environmental and Occupational Lung Disease (Lucknow, India; October, 2000)
- Symposium Coordinator/Chairperson at Society of Toxicology (1993, 1994, 1996-1999; 2005-2009)
- Continuing Education Coordinator/Chairperson at Society of Toxicology (1994, 1995, 2000, 2001)
- Slovenian Society of Toxicology (Nova Gorica, Slovenia; September 2004, 2005)
- Aerosol Dynamics and Health: Strategies to Reduce Exposure & Harm. (Chairperson, Public Health Issues Involving Environmental & Tobacco Aerosols; Cardiff, Wales 2008)
- SOT - Co-Chair, Symposia and Continuing Education Course, 2009, 2010, 2011, 2015, 2016, 2018, 2019
- ISEE/ISES – co-Chair, Symposia on Environmental Contamination and Indigenous populations. (Ontario, Canada, 2018)

FEDERAL & STATE ADVISORY BOARDS/PANELS/REGULATORY AGENCIES **(Contributions to Regulatory Guidelines)**

2018-2019: New York City Housing Authority, Advisory Board member for "Healthy Homes".

2017-2018: National Academy of Science, Engineering, Medicine –
-Board on Earth Sciences & Resources; Board on Environmental Studies & Toxicology; Board on Health Sciences Policy: Potential Human Health Effects of Surface Coal Mining Operations in Central Appalachia. 2017-2019.

2015: European Respiratory Society and Environment and Health Committee for American Thoracic Society. Position paper participant on “What constitutes an adverse health of air pollution?” Brussels, BE, March 2015.

2013: American Chemistry Council’s Center for Advancing Risk Assessment Science and Policy (ARASP) Workshop - Informing Risk Assessment: Understanding and Communicating Uncertainty in Hazard Assessment. (2013)

2011: Department of Defense

- Gulf War Illness Peer Review Panel (2011)

2013: FDA, Tobacco Control Division, Advisory Consultant (2013)

2013-2006: NASA

- Lunar Dust Exposure Standard Review Panel (2013)
- Lunar Science Institute, Moon Science Grant Review Panel (2008)
- Lunar Dust Non-Advocate Review Panel (Chair, 2006-2008)

2002-2012: National Academy of Science

- National Research Council (NRC): Committee on Low Level Lead in Ammunition (2011 – 2012)
- National Research Council (NRC): Peer Review of NRC Report on Acute Exposure Guideline Levels (2010)
- Institute of Medicine (IOM): Peer Review of IOM Report on Depleted Uranium final document (2008)
- National Research Council (NRC) - Committee on Toxicology/Subcommittee on Spacecraft Water Exposure Guidelines (2001 - 2008)
- Institute of Medicine (IOM): Committee on Gulf War and Health - Part 3 (2002 – 2004)
- Institute of Medicine (IOM): Reviewer for Agent Orange final document (2003)

2012-2010: National Toxicology Program, Science Advisory Board (2010-2012)

1996-2017: National Institute of Health (NIH) & National Institute of Environmental Health Science (NIEHS)

NIEHS, Member reviewer for Core Centers (2018)

-NIEHS, Study Section member (2015-2017)

- NIEHS KO1, K99, R23 reviewer (2014, 2015)
- NIEHS KO1, K99 Awards member (2013)
- NIEHS Immunotoxicology Center Program (2012, 2013)
- NIEHS Oceans Centers (2012)
- NIEHS Just-in-time Grants (**Chair**, 2012)
- NIH College of Scientific Reviewers (2010 – 2013)
- NIH Integrative & Comparative Endocrinology (2011)

- NIEHS Time Sensitive Grant (**Chair**; 2010)
- NIEHS P30 (NIEHS Centers of Excellence), (2008, 2009)
- NIEHS Challenge Grants, (2009)
- NIEHS K01 grant applications, (2008)
- NIH Innate Immunity and Inflammation (III) Study Section Full Member, (2005 – 2007)
- NIEHS Program Project grants, (2006)
- NIEHS ALTX – 4 (Alcohol and Toxicology) Study Section Full Member, (1996 – 2000)

2005: National Institute of Environmental Health Sciences (NIEHS) & U.S.EPA & NASA

- Expert Panel on “Global Earth Observations: Application to Air Quality and Human Health” (2005)

2005: National Institute of Allergy & Infectious Disease (NIAID) & Department of Defense (DOD)

- Expert Panel Workshop on Pulmonary Threat Agents (2005)

2013-210: New Jersey Department of Environmental Protection

- Human health Committee (2010 – 2013)
- Soil Standards Sub-committee (2010 – 2011)
- Aerosol Sub-committee (2011 – 2012)

2011-2011: United Nations Environmental Program (UNEP) Steering Committee
(2006 – 2011)

- Atmospheric Brown Cloud Human Health Panel

2004-2005: U.S. EPA Science Advisory Board & Review Panel

- Metals Risk Assessment Framework Review Panel, (**Co-Chair** of Human Health Breakout Group, 2004 – 2005)
- Nanoparticle Review Panel (2005)

APPOINTMENTS/ELECTED OFFICES
Society of Toxicology (SOT)

Nominating Committee (2018-2020)

Committee for Diversity Initiatives (2014-2015, member; 2015-2016, Co-chair; 2015-2016; Chair, 2016--2017)

Board of Councilors (2011 – 2014; **Secretary-elect**, 2011-2012; **Secretary**, 2012-2014)

Nominating Committee (2007 - 2009)

Congressional Representative (2004 – 2005)

Education Committee (2002 – 2005; **Chair**, 2004 – 2005)

Education Sub-Committee for Minority Initiatives (2001 - 2004; **Chair**, 2003-2004)

Continuing Education Committee (1998 - 2001; **Chair**, 1999 - 2000)

Program Committee (1995-1998)

Inhalation & Respiratory Specialty Section

Councilor (2017-2019)

Ethical and Legal Specialty Section

President (2017-2018)
VP-elect (2016)

Immunotoxicology Specialty Section

President (1999-2000)
Vice-President (1998-1999)
Secretary/Treasurer (1995-1997)
Program Committee (1993-1999)
Awards Committee (1993, 1998, 2000)
Education Committee (Chair, 1992-1996; 2004-2009)
Nominating Committee (1998 - 2001, Chair, 1999-2000)
Councilor (2000-2001)

Metals Specialty Section

President (2003-2004)
Vice President (2002-2003)
Awards Committee (**Chair**, 2001 - 2004)
Program Committee (**Chair**, 2001 - 2004)
Nominating Committee (2001 – 2004, **Chair**, 2001-2003)

MidAtlantic (Chapter) Society of Toxicology (MASOT)

Nominating Committee (2009 [**Chair**], 2010, 2011)
Past president, Councilor (2009-2010)
President (2008-2009)
Vice President (2007-2008)
Vice President-elect (2006-2007)
Councilor (2001 - 2004)
Program Committee (2000 – Present; Chair 2006-2007)

NYU Langone School of Medicine

Faculty Council Representative (2010-2019; Vice President 2011-2012, 2014-2015);
Benefits and Tenure Sub-committee (2015-2016)
Academic Affairs Sub-committee (Chair, 2012-Present)
Basic Science Sub-committee (co-Chair, 2017-2019)

IACUC Review Board (2009-2011; 2017-2019)

Grievance Committee (2017-2020)

NYU Senate (alternate; 2018-2021)

Department of Environmental Medicine

Promotion & Tenure Committee (2008-2014; **Chair**, 2010-2012)
Search Committee (2010-2013)
Biological Safety Committee- (**Chair**, 1990-1999)
Graduate Steering Committee (1999- 2014; Interim **Co-chair** 2001-2002)
Toxicology Masters' Program (Director, 2002 – 2008; **Co-director**, 2008-2011)

GRANT REVIEWER *Ad hoc* (Federal [Non-NIH]/State/Private):

Federal

Scandinavian Research Program (2013, 2016)
NASA, Moon dust program (2008)
Canadian Centers for Research (2000 – 2004)
DOD (*Ad hoc*, 1999 - present)

EPA (*Ad hoc*, 2002 - present)
Natural Sciences and Engineering Research Council of Canada (*Ad hoc*, 2002 – present)

State/Private

Center for Indoor Air Research
Environmental and Occupational Science Health Inst. (Rutgers U.)
IFS Research Grants for Developing Nations
Johns Hopkins Pilot Projects
Michigan Sea Grant
New Jersey Sea Grant
New York Sea Grant
Philip Morris Foundation

ADJUNCT APPOINTMENTS, CONSULTING, ADVISORY BOARDS

- **Weill Cornell Medical School** (NY, NY) – External Advisory Board for NIH Diversity Grant (2013-2015)
- **Chulabhorn Research Institute & University** (Bangkok, Thailand) - Adjunct Professor (2003-present)
- **Cornell University, Inst. for Comparative and Environmental Toxicology** (Ithaca, NY) - Adjunct Professor (1996-2005)
- **American Lung Association** - Criteria Document on Woodsmoke (2001)
- **Fish and Wildlife Services** - Status of the Hudson River (2000)
- **International Life Sciences Institute** - Research strategy on age-related differences in susceptibility (1998)
- **Stratus Consulting Inc.** - Assessment of PCB-contaminated sites (1997 - 2000)
- **U.S. EPA** - Criteria document on the immunotoxicity of endocrine disruptors (1997)

MENTORING ON A GLOBAL LEVEL (6)

- Juliet Igbo (Doctoral student co-mentor – U. of Lagos, Nigeria – 2015-2019)
- Anishka Lewis (Masters student- Jamaica – 2014)
- LeighAnn Koekemoer (Masters student – South Africa-2014)
- Dr. Orish Orisakwe – University of Port Harcourt, Nigeria – 2013-present)
- Dr. Hari Jott Dosih (Nepal Health Research Council – Kathmandu, Nepal- 2014-present)
- Dr. Chanthana Tangjarukij (Chulabhorn Research Institute – Bangkok, Thailand- 2012-present)

STUDENT & JUNIOR FACULTY MENTORING

Research Advisor:

College and High School (15)

- Aaron Asiedu-Wiafe (2017-2018; Monroe-Woodbury High School, Monroe, NY)
- Aastha Parikh (2016-2017; Monroe-Woodbury High School, Monroe, NY)
- Daniel Smith (2013-2014; Fairlawn High School, Fairlawn, NJ)
- Alejandro Jorge (2012; Ramapo College, NJ)
- Eric Bloom (2011-2012; Highland Mills High School [Highland Mills, NY])
- Sujay Avencar (2009-2011; Suffern High School [Suffern, NY])
- Sam Openheim (2009-2011; Suffern High School [Suffern, NY])
- Monica Feldman (2007-2009; Spring Valley High School [Spring Valley, NY])

- George Markt (2005-2009; Ramapo High School [Ramapo, NY])
- Payal Roy (2006 – 2007; New York University [NY, NY])
- Rebecca Kurtzman (2005 – 2007; Spring Valley High School [Spring Valley, NY])
- Erica Stone (2006, Ramapo College [Mahwah, NJ])
- Elizabeth Nadziejko (2000; Washingtonville High School [Washingtonville, NY])
- Kevin Hazard (1999 – 2000; Spring Valley High School [Spring Valley, NY])
- Songeeta Pachachuria (1997-2000; Spring Valley High School, [Spring Valley, NY])

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Post-Baccalaureate (2)

- *Parnavi Desai* (2015-present; NYU, Biology)
- *Tomas Dunne* (2014-2015; Penn State)

Masters (30)

- Arianna Schwartzer (2017-2019; NYU Environ. Health Sci)
- Kathryn Fetce (2016-2018; NYU Environmental Health Sciences)
- Nicholas Lawrence (2016-2018; NYU Environmental Health Sciences)
- Alexander Lucca (2017-2018; NYU Biology)
- Annie J. Thaikkatil (2016-2017; NYU Biology)
- Leena Babiker (2017-2018; NYU Biology)
- Patricia Costa (2014-2016; NYU Environ. Health Sci)
- Maria Putilina (2013-2014-NYU, Biology)
- Kirtan Kaur (2013-2015)
- Sarah Attreed (2013-2015)
- Sabina Sutjec (2013-2014-NYU, Biology)
- Kaitlyn Koenig (2012-2014)
- Heather Larkin (2012-2013-NYU, Biology))
- Dana Lauterstein (2011-2013) – 2 SOT student awards (2013)
- Yi-Chuh Chen (2010-2011 Incomplete-NYU Biology)
- Ya-Chien Yu (2010-2011-IncompleteNYU Biology)
- Yuan-Chun Hsiao (2010-2011-Incomplete NYU Biology)
- Lauren Rosenblum (2009-2011-NYU Biology)
- Sandra Perella (2008-2010)
- Kotaro Hoshido (2007-2009-NYU Biology)
- Jacqueline Grabowski (2006-2008)
- Elizabeth Vanza (2004 – 2006) – *SOT student award (2006)*
- Elizabeth Berg (2003 - 2005)
- Shannon Doherty (2002 - 2005)
- Colette Prophete (1998 - 2001)
- Jessica Duffy (1999 - 2001)
- Migali Jorge (1998 - 2000)
- Cheryl Premdass (1998 - 2000)
- Andrea Raymond (1997 - 2000) – *1 SOT award*
- Thomas McManus (1994 – 1996, Co-advisor)

Doctorate (9)

- Pamela Tijerna (2013-present) – *SOT CDI award (2014); SOT (1st place Hispanic Organization of Toxicology, 2015); SOT(Mary Amdur Inhalation Fellowship, 2015)*
- Dana Lauterstein (2013-present)- *SOT (Safety Assessment Specialty Section, 2015)*
- Juliett Igbo (2015-2016), Co-Advisor (U. of Lagos, Nigeria)
- Sheung Pui Ng (2004 - 2010) – *9 SOT student awards including Novartis Achievement Award (2008-2010)*
- Jessica Duffy (2001 – 2007) – *2 SOT awards (2004); 3 SETAC awards (2004, 2005, 2006)*
- Chanthana Settachan (Co-Advisor; 2003 – 2009; Chulabhorn Research Institute, Bangkok Thailand)
- Erik Carlson (1999- 2003) – *1 SOT award (2000)*
- Ninah Enane (Co-Advisor, 1995 - 1999)
- Peter Atkins (Co-Advisor, 1992 - 1996)

Post-doctoral Trainees (2) & Mentoring Committees

- Jason Blum (2009 – 2012) – *1 SOT post-doc award*
- Daniel Willis (2011 – 2013)- *NSF/FDA post-doctoral fellowship (Zelikoff, PI)- 2013*

Junior Faculty Mentoring Committee (2)

- Jason Blum (2012 – Present)
- Kevin Cromar (2012-Present)

Doctoral Thesis Committee (12):

- Kirtan Kaur (2016-2018, Chair)
- Carolyn Klocke (2015-2017) – University of Rochester (External Examiner)
- Mary Francis (2015-2016) - Rutgers University (External Examiner)
- Eric Saunders (2012-2015)
- Joshua Vaughn (2012 – 2015)
- AJ Cuevas (2007 – 2012)
- Jessica Lyon (2007 - 2012)
- Judy Blatt Nichols (Chair, 2007 – 2011)
- Patricia Gillespie (2006 - 2010)
- Elizabeth Vanza (Chair, 2004 – 2009)
- Ann Zulkosky (2005 – 2007; SUNY Stony Brook)
- Samantha DeLeon (Chair, 1999 – 2003)

COMMUNITY OUTREACH, EDUCATION & ENGAGEMENT INITIATIVES:

- **Director**, *Community Outreach & Education Program, NYU, Dept. of Environ. Med. (2005- present)*
- **Director**, *NIEHS Center of Excellence, Community Outreach & Engagement Program, NYU, Dept. of Env. Med. (2005 – present)*
- **Director**, *NIEHS Superfund Community Outreach and Education Core, NYU, Dept. of Environ. Med. (2005- 2010)*

- **Co-director**, NIEHS Superfund Translation Core, *NYU, Dept. of Environ. Med.* (2005- 2011)

Community Partners:

- *Ironbound Community Corporation (ICC): Newark, NJ (2015-present)*
- *Ramapough Lenape Tribal Nation: Ringwood, NJ/Mahwah, NJ/Hillburn, NY (2013-present)*
- *City of Garfield, NJ (2012-present)*
- *Susquehanna, PA: Fracking communities (2015-2016)*
- *Flint, Michigan via Water Defense*

Translation/Communication of toxicology to non-toxicologists & underserved minorities

- Community groups in PA and NY: Environmental and Health Implications of Hydraulic Fracturing (2013-2014).
- Ramapo Indians: Living on a Superfund Site (2014-present)
- NY Presbyterian Lang Program for Underserved Youth (2010 - Present)
- *Harlem Children Society Mentoring Program - Bronx, NY (2010-Present)*
- Y-2 Kids (NY State 4th – 12th grade, Career day representative, 2008 - Present)
- *Center for Talented Youth, New York University Department of Environmental Medicine & Johns Hopkins Center for Talented Youth (2005 – Present)*
- *Environmental Commission of Ramsey (2001 – 2007; Vice-Chair; 2004-2006)* - Ramsey, New Jersey. Woodburning: A Cozy Atmosphere or a Public Menace? (2003)
- *Senior Citizen Advisory Board of Ramsey (2003 - 2005)*
- *Ramsey High School (Presenter on toxicology and the environment 2005-2006)*
- *Youth Guidance Commission of Ramsey (1999 - 2001)*
- *Rotary Club, Goshen, New York. Woodburning: A Cozy Atmosphere or a Public Menace? (2003)*
- *Upper Saddle River Community Center, Upper Saddle River, New Jersey. The Hazards of Woodburning (1997)*

Non-Academic Related Outreach Committees:

- 2011- 2014 – *Board of Ethics*, Community Hospice of Bergen County (NJ)
- 2009- 2014 – *Fundraising Committee*, Community Hospice of Bergen County (NJ)
- 2006-2013 – President, Condominium Association
- 2013-2016 – Vice-President, Condominium Association
- 2018 – South Bronx Asthma Coalition

Exhibit B

MATERIALS AND DATA CONSIDERED

Literature

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- Abubaker, Kalid, Rodney B. Luwor, et al. "Targeted disruption of the JAK2/STAT3 pathway in combination with systemic administration of paclitaxel inhibits the priming of ovarian cancer stem cells leading to a reduced tumor burden." *Frontiers in Oncology* No. 4(75) (2014).
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JNJNL61_00000266
JNJMX68_000003729 (Exhibit J&J-185)
JNJMX68_000004296
JNJMX68_000012745
JNJMX68_000013019
JNJMX68_000022920
JNJNL61_000001341
JNJNL61_000005343
JNJNL61_000006591
JNJNL61_000006591
JNJNL61_000006591
JNJNL61_000006792

JNJNL61_000023234

JNJNL61_000024449

JNJNL61_000024650

JNJNL61_000024657

JNJNL61_000025152

JNJNL61_000027053

JNJNL61_000032036

JNJNL61_000033574

JNJNL61_000043243

JNJNL61_000043244

JNJNL61_000043245

JNJNL61_000043246

JNJNL61_000043271

JNJNL61_000043272

JNJNL61_000064161

JNJNL61_000064162

JNJNL61_000079334

JNJNL61_000090039

JNJS71R_000000139

JNJS71R_000001978

JNJS71R_000002199

JNJS71R_000007083

JNJS71R_000009825

JNJS71R_000011316

JNJTALC000384809

JNJTALC000864509

JNJTALC000878141

JOJO-MA2330

Depositions

Deposition of Alice M. Blount Dated 4.13.2018

Deposition and Exhibits of Laura M. Plunkett Dated 1.11.2017-1.13.2017

Deposition of Dr. Thomas Dydek Dated 8.21.18

Deposition and Exhibits of John Hopkins Dated 8.16.18-8.17.18

Deposition and Exhibits of Julie Pier Dated 9.12.18-9.13.18

Deposition and Exhibits of Pat Downey Dated 8.7.18-8.8.18

Deposition of Robert Glenn Dated 10.18.18

Deposition and Exhibits of Donald Hicks Dated 6.28.18-6.29.8

Reports

Expert Report of Michael M. Crowley, PhD

Expert Report of William E. Longo, PhD and Mark W. Rigler PhD. Analysis of J&J Baby Powder & Valiant Shower to Shower Talc Products for Amphibole (Tremolite) Asbestos Expert Report. August 2, 2017.

Expert Report of William E. Longo, PhD, Mark W. Rigler, PhD and William B. Egeland, M.S., P.G. Below the Waist Application of J&J Baby Powder Expert Report. September, 2017.

Expert Report of William E. Longo, PhD and Mark W. Rigler PhD. TEM Analysis of Historical 1978 Johnson's Baby Powder Sample for Amphibole Asbestos. February 16, 2018.

Expert Report of William E. Longo, PhD and Mark W. Rigler, PhD. November. 14, 2018.

Expert Report (Brower v. J&J) of Dr. Thomas Dydek

Expert Report (Brower v. J&J) of Dr. Laura Plunkett

Supplmental Expert Report (Brower v. J&J) of Dr. Laura Plunkett

Exhibit 43



WORLD HEALTH ORGANIZATION

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER

IARC MONOGRAPHS
ON THE
EVALUATION OF CARCINOGENIC
RISKS TO HUMANS

Chromium, Nickel and Welding

VOLUME 49

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1990

CHROMIUM AND CHROMIUM COMPOUNDS

Chromium and chromium compounds were considered by previous IARC Working Groups, in 1972, 1979, 1982 and 1987 (IARC, 1973, 1979, 1980a, 1982, 1987a). Since that time, new data have become available, and these are included in the present monograph and have been taken into consideration in the evaluation.

1. Chemical and Physical Data

The list of chromium alloys and compounds given in Table 1 is not exhaustive, nor does it necessarily reflect the commercial importance of the various chromium-containing substances, but it is indicative of the range of chromium alloys and compounds available.

1.1 Synonyms, trade names and molecular formulae of chromium and selected chromium-containing compounds

Table 1. Synonyms (Chemical Abstracts Service names are given in bold), trade names and atomic or molecular formulae of chromium and selected chromium compounds

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Metallic chromium [0] and chromium [0] alloys			
Chromium	7440-47-3	Chrome	Cr
Cobalt-chromium alloy ^c	11114-92-4 (91700-55-9)	Chromium alloy (nonbase), Co, Cr; cobalt alloy (non-base), Co, Cr	-
Cobalt-chromium-molybdenum alloy ^c	12629-02-6 (8064-15-1; 11068-92-1; 12618-69-8; 55345-18-1;	Cobalt alloy (base), Co 56-68, Cr 25-29, Mo 5-6, Ni 1.8-3.8, Fe 0-3, Mn 0-1, Si 0-1, C 0.2-0.3 (ASTM A567-1)	

Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
	60382-64-1; 83272-15-5; 85131-98-2; 94076-26-3)	Akrit CoMo35; AMS 5385D; Celsit 290; F 75; HS 21; Protasul-2; Stellite 21; Vinertia; Vitallium; X25CoCr-Mo62 28 5; Zimalloy	
Chromium-containing stainless steels ^c	71631-40-8 (51204-69-4, 59601-19-3, 84723-14-8, 94197-89-4, 98286-69-2)	Iron alloy (base), Fe 64-72, Cr 21-23, Ni 4.5-6.5, Mo 2.5-3.5, Mn 0-2, Si 0-1, N 0.1-0.2 (ASTM A276-S31803) AF 22; AF 22-130; AISI 318L; Alloy 2205; Arosta 4462; AST 2205; Avesta 2205; Avesta 223FAL; CR22; 22Cr; 22Cr5Ni; CrNiMoN22-5-3; DIN 1.4462; ES 2205; FAL 223; 744LN; Mann AF-22; Nirosta 4462; NKK-Cr22; Novonox FALC 223; NU 744 LN; NU stainless 744LN; Remanit 4462; SAF 2205; Sandvik SAF 2205; SS 2377; Stainless steel 2205; Uddeholm Nu744LN; UHB 744LN; UNS S31803; Uranus 45N; UR45N; Vallourec VS22; VEW A903; VLX 562; VS 22; X2CrNiMoN2253; Z2 CND 22.5 AZ	-
Ferro-chrome ^d	11114-46-8 (11133-75-8, 11143-43-4, 12604-52-3)	Chromium alloy (base), Cr, C, Fe, N, Si; ferrochromium; carbon ferrochromium; chrome ferroalloy; chromium ferroalloy	-
Iron-nickel-chromium alloy	11121-96-3	Iron alloy (base), Fe 39-47, Ni 30-35, Cr 19-23, Mn 0-1.5, Si 0-1, Cu 0-0.8, Al 0-0.6, Ti 0-0.6, C 0-0.1 (ASTM B163-800) AFNOR ZFeNC45-36; AISI 332; Alloy 800; Alloy 800NG; Cr20Ni32TiAl; 20Cr32NiTiAl; DIN 1.4876; FeCr21Ni32TiAl; IN 800; Incoloy 800; JIS NCF800; N800; NCF800; NCF 800 HTB; NCF steel; Nickel 800; Nicrofer 3220; Ni33Cr21TiAl; POLDI AKR 17; Pyromet 800; Sanicro 31; Thermax 4876; TIG N800	-
Nickel-chromium alloy	12605-70-8	Nichrome; Nickel alloy (base), Ni 57-62, Fe 22-28, Cr 14-18, Si 0.8-1.6, Mn 0-1, C 0-0.2 (ASTM B344-60 Ni, 16 Cr) Chromel C; Kh15N60N; NiCr6015; PNKh; Tophet C	-
Chromium [III] compounds			
Basic chromic sulfate	12336-95-7 (39380-78-4)	Basic chromium sulfate; chromium hydroxide sulfate (Cr(OH)(SO₄)); chromium sulfate; monobasic chromium sulfate; sulfuric acid, chromium salt, basic Chromedol; Chrometan; Chrome tan; Peachrome	Cr(OH)SO ₄
	64093-79-4	Neochromium	Cr(OH)SO ₄ ·Na ₂ SO ₄ ·H ₂ O

CHROMIUM AND CHROMIUM COMPOUNDS

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Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Chromic acetate	1066-30-4	Acetic acid, chromium (3+) salt; chromium acetate; chromium [III] acetate; chromium triacetate	Cr(OCOCH ₃) ₃
Chromic chloride	10025-73-7	Chromium chloride (CrCl ₃); chromium [III] chloride; chromium trichloride; C.I. 77295; trichlorochromium	CrCl ₃
Chromic hydroxide	1308-14-1	Chromic acid (H ₃ CrO ₃); chromium hydroxide (Cr(OH) ₃); chromium [III] hydroxide; chromium (3+) hydroxide; chromium trihydroxide	Cr(OH) ₃
Chromic nitrate	13548-38-4 (20249-21-2)	Chromium nitrate; chromium [III] nitrate; chromium (3+) nitrate; chromium trinitrate; nitric acid, chromium (3+) salt	Cr(NO ₃) ₃
Chromic oxide	1308-38-9	Chrome oxide; chromia; chromium oxide (Cr ₂ O ₃); chromium [III] oxide; chromium sesquioxide; chromium (3+) trioxide; C.I. 77288; C.I. Pigment Green 17; dichromium trioxide Anadonis Green; Casalis Green; Chrome Green; Chrome Ochre; Chrome Oxide Green BX; Chrome Oxide Green GN-M; Chromium Oxide Pigment; Chromium 111 Oxide; Chromium Oxide Green; Chromium Oxide X1134; 11661 Green; Green Chrome Oxide; Green Chromic Oxide; Green Chromium Oxide; Green Cinnabar; Green Oxide of Chromium; Green Oxide of Chromium OC-31; Green Rouge; Guignet's Green; Leaf Green; Levanox Green GA (hydrated chromic oxide); Oil Green; Oxide of Chromium; P-106F10; Pure Chromium Oxide Green 59; Ultramarine Green	Cr ₂ O ₃
Chromic perchlorate	13537-21-8	Chromium perchlorate; chromium triperchlorate; perchloric acid, chromium (3+) salt	Cr(ClO ₄) ₃
Chromic phosphate	7789-04-0	Chromium monophosphate; chromium orthophosphate; chromium phosphate; phosphoric acid, chromium (3+) salt (1:1); phosphoric acid, chromium [III] salt	CrPO ₄
Chromic sulfate	10101-53-8 (39378-25-1)	Arnaudon's Green (hemiheptahydrate); Plessy's Green (hemiheptahydrate) Chromium sulfate (2:3); chromium [III] sulfate; dichromium sulfate; dichromium tris(sulfate); dichromium trisulfate; sulfuric acid, chromium (3+) salt (3:2); C.I. 77305	Cr ₂ (SO ₄) ₃
Chromite ore	1308-31-2 (61026-56-0)	Baychrom A; Baychrom F; Chromitan B; Chromitan MS; Chromitan NA; Cromitan B; Koreon Chrome ore; chromite (Cr ₂ FeO ₄); chromite mineral; iron chromite	Cr ₂ O ₃ .FeO
Nickel chromate	12018-18-7	Chromic acid (H ₂ CrO ₄), nickel salt (1:1)	NiCrO ₄

Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Potassium chromic sulfate	10141-00-1 (14766-82-6; 81827-72-7; 81827-73-8)	Chrome alum; chrome potash alum; chromic potassium sulfate; chromium potassium sulfate; potassium chromium alum; potassium chromium sulfate; potassium disulfatochromate [III]; sulfuric acid, chromium (3+) potassium salt (2:1:1)	KCr(SO ₄) ₂
Chromium[VI] compounds			
Ammonium chromate	7788-98-9	Chromic acid, ammonium salt; chromic acid (H₂CrO₄), diammonium salt ; diammonium chromate; neutral ammonium chromate	(NH ₄) ₂ CrO ₄
Ammonium dichromate	7789-09-5	Ammonium bichromate; ammonium chromate; chromic acid (H₂Cr₂O₇), diammonium salt ; diammonium dichromate; dichromic acid, diammonium salt	(NH ₄) ₂ Cr ₂ O ₇
Barium chromate	10294-40-3 (12000-34-9; 12231-18-4)	Barium chromate (VI); barium chromate (1:1); barium chromate oxide; chromic acid (H₂CrO₄), barium salt (1:1) ; C.I. 77103; C.I. Pigment Yellow 31	BaCrO ₄
Basic lead chromate	1344-38-3 (54692-53-4)	Baryta Yellow; Lemon Chrome; Lemon Yellow; Permanent Yellow; Steinbuhl Yellow; Ultramarine Yellow	PbO.PbCrO ₄
		C.I. 77601; C.I. Pigment Orange 21 ; C.I. Pigment Red; lead chromate oxide	
		Arancio Cromo; Austrian Cinnabar; Basic Lead Chromate Orange; Chinese Red; Chrome Orange; Chrome Orange 54; Chrome Orange 56; Chrome Orange 57; Chrome Orange 58; Chrome Orange Dark; Chrome Orange Extra Light; Chrome Orange G; Chrome Orange Medium; Chrome Orange NC-22; Chrome Orange R; Chrome Orange 5R; Chrome Orange RF; Chrome Orange XL; Chrome Red; C.P. Chrome Orange Dark 2030; C.P. Chrome Orange Extra Dark 2040; C.P. Chrome Orange Light 2010; C.P. Chrome Orange Medium 2020; Dainichi Chrome Orange R; Dainichi Chrome Orange 5R; Genuine Acetate Orange Chrome; Genuine Orange Chrome; Indian Red; International Orange 2221; Irgachrome Orange OS; Light Orange Chrome; No. 156 Orange Chrome; Orange Chrome; Orange Nitrate Chrome; Pale Orange Chrome; Persian Red; Pigment Orange 21; Pure Orange Chrome M; Pure Orange Chrome Y; Red Lead Chromate; Vynamon Orange CR	
Calcium chromate	13765-19-0	Calcium chromium oxide; calcium monochromate; chromic acid (H₂CrO₄), calcium salt (1:1) ; C.I. 77223; C.I. Pigment Yellow 33	CaCrO ₄
		Calcium Chrome Yellow; Gelbin; Yellow Ultramarine	

CHROMIUM AND CHROMIUM COMPOUNDS

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Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Chromium [VI] chloride	14986-48-2	Chromium hexachloride; (OC-6-11)-chromium chloride (CrCl ₆)	CrCl ₆
Chromium trioxide	1333-82-0 (12324-05-9; 12324-08-2)	Chromia; chromic acid; chromic [VI] acid; chromic acid, solid; chromic anhydride; chromic trioxide; chromium oxide (CrO ₃); chromium [VI] oxide; chromium (6+) trioxide; monochromium trioxide	CrO ₃
Chromyl chloride	14977-61-8	Chlorochromic anhydride; chromium chloride oxide; chromium dichloride dioxide; chromium, dichloro-dioxo-(T-4) ; chromium dioxide dichloride; chromium dioxychloride; chromium oxychloride; dichlorodioxochromium	CrO ₂ Cl ₂
Lead chromate	7758-97-6 (8049-64-7)	Chromic acid (H ₂ CrO ₄), lead (2+) salt (1:1) ; C.I. 77600; C.I. Pigment Yellow 34; crocoite; lead chromium oxide; phoenicochroite; plumbous chromate Canary Chrome Yellow 40-2250; Chrome Green; Chrome Green UC61; Chrome Green UC74; Chrome Green UC76; Chrome Lemon; Chrome Yellow; Chrome Yellow 5G; Chrome Yellow GF; Chrome Yellow LF; Chrome Yellow Light 1066; Chrome Yellow Light 1075; Chrome Yellow Medium 1074; Chrome Yellow Medium 1085; Chrome Yellow Medium 1295; Chrome Yellow Medium 1298; Chrome Yellow Primrose 1010; Chrome Yellow Primrose 1015; Cologne Yellow; Dainichi Chrome Yellow G; LD Chrome Yellow Supra 70 FS; Leipzig Yellow; Paris Yellow; Pigment Green 15; Primrose Chrome Yellow; Pure Lemon Chrome L3GS	PbCrO ₄
Molybdenum orange	12656-85-8	C.I. Pigment Red 104 Chrome Vermilion; Krolor Orange RKO 786D; Lead chromate molybdate sulfate red; Mineral Fire Red 5DDS; Mineral Fire Red 5GGS; Mineral Fire Red 5GS; Molybdate Orange; Molybdate Orange Y 786D; Molybdate Orange YE 421D; Molybdate Orange YE 698D; Molybdate Red; Molybdate Red AA 3; Molybden Red; Molybdenum Red; Renol Molybdate Red RGS; Vynamon Scarlet BY; Vynamon Scarlet Y	PbMoO ₄ ·PbCrO ₄ ·PbSO ₄
Potassium chromate	7789-00-6	Bipotassium chromate; chromic acid (H ₂ CrO ₄), dipotassium salt ; dipotassium chromate; dipotassium monochromate; neutral potassium chromate; potassium chromate [VI]	K ₂ CrO ₄

Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Potassium dichromate	7778-50-9	Chromic acid ($\text{H}_2\text{Cr}_2\text{O}_7$), dipotassium salt ; dichromic acid, dipotassium salt; dipotassium bichromate; dipotassium dichromate; potassium bichromate; potassium dichromate [VI]	$\text{K}_2\text{Cr}_2\text{O}_7$
Sodium chromate	7775-11-3	Chromic acid (H_2CrO_4), disodium salt ; chromium disodium oxide; chromium sodium oxide; disodium chromate; neutral sodium chromate; sodium chromium oxide	Na_2CrO_4
Sodium dichromate	10588-01-9 (12018-32-5)	Bichromate of soda; chromic acid ($\text{H}_2\text{Cr}_2\text{O}_7$), disodium salt ; chromium sodium oxide; dichromic acid, disodium salt; disodium dichromate; sodium bichromate; sodium dichromate [VI]	$\text{Na}_2\text{Cr}_2\text{O}_7$
Strontium chromate	7789-06-2 (54322-60-0)	Chromic acid (H_2CrO_4), strontium salt (1:1); C.I. Pigment Yellow 32; strontium chromate [VI]; strontium chromate (1:1) Deep Lemon Yellow; Strontium Chromate 12170; Strontium Chromate A; Strontium Chromate X-2396; Strontium Yellow; Sutokuro T	SrCrO_4
Zinc chromate ^e	13530-65-9 (1308-13-0; 1328-67-2; 14675-41-3)	Chromic acid (H_2CrO_4), zinc salt (1:1); chromium zinc oxide; zinc chromium oxide; zinc tetraoxychromate; zinc tetroxochromate Buttercup Yellow	ZnCrO_4
Zinc chromate hydroxides	15930-94-6 (12206-12-1; 66516-58-3)	Basic zinc chromate; chromic acid (H_6CrO_6), zinc salt (1:2); chromic acid (H_4CrO_5), zinc salt (1:2), monohydrate; chromium zinc hydroxide oxide; zinc chromate hydroxide; zinc chromate [VI] hydroxide; zinc chromate oxide ($\text{Zn}_2(\text{CrO}_4)\text{O}$), monohydrate ; zinc hydroxychromate; zinc tetrahydroxychromate; zinc yellow ^f	$\text{Zn}_2\text{CrO}_4(\text{OH})_2$ and others
Zinc potassium chromates (hydroxides)	11103-86-9 (12527-08-1; 37809-34-0)	Basic zinc potassium chromate; chromic acid ($\text{H}_6\text{Cr}_2\text{O}_8$), potassium zinc salt (1:1:2); potassium hydroxyoctaoxodizincatedichromate (1-); potassium zinc chromate hydroxide; zinc yellow ^f	$\text{KZn}_2(\text{CrO}_4)_2(\text{OH})$ and others
Other chromium compounds			
Chromium carbonyl	13007-92-6 (13930-94-4)	Chromium carbonyl ($\text{Cr}(\text{CO})_6$); chromium hexacarbonyl; hexacarbonyl chromium	$\text{Cr}(\text{CO})_6$
Chromic chromate	24613-89-6	Chromic acid (H_2CrO_4), chromium (3+) salt (3:2); chromium chromate	$\text{Cr}_2(\text{CrO}_4)_3$
Chromium [II] chloride	10049-05-5	Chromium chloride (CrCl_2); chromium dichloride; chromous chloride	CrCl_2

CHROMIUM AND CHROMIUM COMPOUNDS

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Table 1 (contd)

Chemical name	Chem. Abstr. Services Reg. No. ^a	Synonyms and trade names	Formula ^b
Chromium [IV] dioxide	12018-01-8	Chromium dioxide; chromium oxide (CrO ₂); chromium [IV] oxide	CrO ₂

^a Replaced CAS Registry numbers are given in parentheses.

^b Compounds with the same synonym or trade name can have different formulae.

^c Thousands of alloys of chromium with other metals are listed by the Chemical Abstracts Registry Service; approximately 1300 contain cobalt, over 400 also contain molybdenum and nearly 100 are chromium-containing stainless steels. An example of each is listed here.

^d Chemical Abstracts Registry Service lists several ferrochromium alloys; one example is given.

^e The term 'zinc chromate' is also used to refer to a wide range of commercial zinc and zinc potassium chromates.

^f 'Zinc yellow' can refer to several zinc chromate pigments; it has the CAS No. 37300-23-5.

1.2 Chemical and physical properties of pure substances

Known physical properties of some of the chromium compounds considered in this monograph are given in Table 2. Data on solubility refer to saturated solutions in water or other specified solvents. Hexavalent chromium compounds are customarily classed as soluble or insoluble in water; such a classification is useful in industry but might not be relevant to determining the biological properties of a compound. There is thus no general agreement on the definition of solubility: in practice, the aqueous solubility of Cr[VI] compounds has been classified as prompt (1 min) and short-term (30 min) (Van Bemst *et al.*, 1983). In laboratory studies, solubilization depends on, e.g., the medium used in in-vitro tests; for human exposures, solubility is related to the chemical environment in the respiratory tract. Examples of soluble hexavalent chromium compounds are sodium chromate (873 g/l at 30°C) and potassium chromate (629 g/l at 20°C). Hexavalent chromium compounds classed as insoluble include barium chromate (4.4 mg/l at 28°C) and lead chromate (0.58 mg/l at 25°C) (Windholz, 1983; Weast, 1985). Compounds with solubilities towards the middle of this range are not easily classified, and technical-grade compounds, such as the various zinc chromates, can have a wide range of solubilities.

1.3 Technical products and impurities

(a) Chromite ore

Chromite ore consists of varying percentages of chromium, iron, aluminium and magnesium oxides as the major components. It has been classified into three

Table 2. Physical properties of chromium and chromium compounds^a

Chemical name	Atomic/ molecular weight	Melting- point (°C)	Boiling- point (°C)	Typical physical description	Solubility
Metallic chromium [0]					
Chromium	51.996	1900	2642	Steel-grey, lustrous metal or powder	Insoluble in water; soluble in dilute hydrochloric acid and sulfuric acid; insoluble in nitric acid or nitrohydrochloric acid
Chromium[III] compounds					
Basic chromic sulfate ^b	165.06	--	--	Green powder	Soluble in water (approximately 700 g/l at 35°C ^b)
Chromic acetate (hydrate)	229.14 (247.15)	--	--	Grey-green powder (blue-violet needles)	Slightly soluble in water; insoluble in ethanol; soluble in cold water, acetone (2 g/l at 15°C) and methanol (45.4 g/l at 15°C)
Chromic chloride (hexahydrate)	158.36 (266.45)	1150 (83)	Sublimes at 1300	Violet crystalline scales	Anhydrous form is insoluble in cold water, slightly soluble in hot water, but insoluble in ethanol, acetone, methanol and diethyl ether. The hydrated form is very soluble in water (585 g/l), soluble in ethanol, slightly soluble in acetone and insoluble in diethyl ether.
Chromic nitrate (7.5 hydrate) (nonahydrate)	238.03 (373.13) (400.15)	- (100) (60)	- Decomposes Decomposes at 100	Pale-green powder (brown crystals) (deep-violet crystals)	Soluble in water. Both hydrated forms soluble in water; the nonahydrate is soluble in acids, alkali, ethanol and acetone
Chromic oxide	151.99	2435	4000	Light to dark-green, fine crystals	Insoluble in water, acids, alkali and ethanol
Chromic phosphate (dihydrate)	147 (183.00)	> 1800°C	--	Violet crystalline solid	Insoluble in water. Hydrated form is slightly soluble in cold water; soluble in most acids and alkali but not in acetic acid

Table 2 (contd)

Chemical name	Atomic/ molecular weight	Melting- point (°C)	Boiling- point (°C)	Typical physical description	Solubility
Chromic sulfate	392.16	--	--	Violet or red powder	Insoluble in water; slightly soluble in ethanol; insoluble in acids
Potassium chromic sulfate (dodecahydrate)	283.23 (499.39)	(89)	(400)	(Violet ruby-red to black crystals)	Hydrated form is soluble in water (243.9 g/l at 25°C; 500 g/l in hot water); slightly soluble in dilute acids; insoluble in ethanol
Chromium[VI] compounds					
Ammonium chromate	152.07	180	--	Yellow acicular crystals	Soluble in water (405 g/l); insoluble in ethanol, slightly soluble in ammonia, acetone and methanol
Ammonium dichromate	252.06	170 (dec) ^c	--	Orange-red crystals	Soluble in water (308 g/l at 15°C; 890 g/l at 30°C) and ethanol; insoluble in acetone
Barium chromate	253.33	--	--	Yellow crystals	Very slightly soluble in water (4.4 mg/l at 28°C); soluble in mineral acids
Basic lead chromate	546.37	--	--	Red crystalline powder	Insoluble in water; soluble in acids and alkali
Calcium chromate (dihydrate)	156.09 (192.10)	(200)	--	Yellow crystalline powder	Slightly soluble in water and ethanol; soluble in acids. Hydrated form is soluble in water (163 g/l at 20°C; 182 g/l at 45°C), acids and ethanol
Chromium trioxide	99.99	196	Decomposes at 250 ^c	Dark-red crystals, flakes or granular powder	Soluble in water (625 g/l at 20°C; 674.5 g/l at 100°C), ethanol, diethyl ether and sulfuric and nitric acids
Chromyl chloride	154.90	-96.5	117	Dark-red volatile liquid	Decomposes in water and ethanol; soluble in ether, acetic acid, carbon tetrachloride, carbon disulfide, benzene, nitrobenzene, chloroform and phosphorous oxychloride

Table 2 (contd)

Chemical name	Atomic/ molecular weight	Melting- point (°C)	Boiling- point (°C)	Typical physical description	Solubility
Lead chromate	323.18	844	Decomposes	Yellow to orange-yellow crystalline powder	Very slightly soluble in water (0.58 mg/l at 25°C); soluble in most acids and alkali but not in acetic acid or ammonia
Nickel chromate	174.71	—	—	—	Insoluble in water; soluble in nitric acid and hydrogen peroxide
Potassium chromate	194.20	968.3	Decomposes ^c	Lemon-yellow crystals	Soluble in water (629 g/l at 20°C; 792 g/l at 100°C); insoluble in ethanol
Potassium dichromate	294.19	398	Decomposes at 500	Bright orange-red crystals	Soluble in water (49 g/l at 0°C; 1020 g/l at 100°C); insoluble in ethanol
Sodium chromate	161.97	792	Decomposes ^c	Yellow crystals	Soluble in water (873 g/l at 30°C) and methanol (3.44 g/l at 25°C); slightly soluble in ethanol
Sodium dichromate (dihydrate)	262.00 (298.00)	356.7	Decomposes at 400 ^c	Reddish to bright-orange crystals	Soluble in water (2380 g/l at 0°C; 5080 g/l at 80°C); and methanol (513.2 g/l at 19.4°C); insoluble in ethanol
Strontium chromate	203.61	Decomposes ^d	—	Yellow crystalline powder	Slightly soluble in water (1.2 g/l at 15°C; 30 g/l at 100°C); soluble in hydrochloric, nitric and acetic acids and ammonium salts
Zinc chromate	181.37	—	—	Lemon-yellow crystals	Insoluble in cold water; decomposes in hot water; soluble in acids and liquid ammonia
Zinc chromate hydroxide	280.74	—	—	Fine yellow powder	Slightly soluble in water; soluble in dilute acids, including acetic acid
Other chromium compounds					
Chromium carbonyl	220.06	Decomposes at 110	Explodes at 210	Colourless crystals or white solid	Insoluble in water; slightly soluble in carbon tetrachloride and iodoform; insoluble in ethanol, diethyl ether and acetic acid

Table 2 (contd)

Chemical name	Atomic/ molecular weight	Melting- point (°C)	Boiling- point (°C)	Typical physical description	Solubility
Chromium [II] chloride	122.90	824	--	White lustrous needles or fused fibrous mass	Soluble in water; insoluble in ethanol and diethyl ether
Chromium dioxide	83.99	300	--	Brown-black crystalline powder	Insoluble in water; soluble in nitric acid

^aFrom Windholz (1983) and Weast (1985), unless otherwise specified

^bFrom British Chrome & Chemical Ltd (1988)

^cFrom Udy (1956)

^dFrom Hartford (1979)

general grades associated with their use and chromic oxide content: metallurgical (greater than 46%), chemical (40-46%) and refractory (less than 40%) grades (Papp, 1985). During the past two decades, technological advances have allowed considerable interchangeability among the various grades, particularly the so-called chemical grade which can be utilized in all three industries. A more definitive classification is: (i) 'high-chromium' chromite (metallurgical-grade), containing a minimum of 46% chromic oxide and a chromium:iron ratio greater than 2:1; (ii) 'high-iron' chromite (chemical-grade), with 40-46% chromic oxide and a chromium:iron ratio of 1.5:1 to 2:1; and (iii) 'high-aluminium' chromite (refractory-grade), containing more than 20% aluminium oxide and more than 60% aluminium oxide plus chromic oxide (Papp, 1983).

Chromite from one US processor had the following typical analysis: chromium (as chromic oxide), 45.57%; iron (as ferric oxide), 29.80%; aluminium (as aluminium oxide), 13.80%; magnesium (as magnesium oxide), 9.28%; silicon (as silicon dioxide), 1.13%; and calcium (as calcium oxide), 0.40% (Cyprus Specialty Metals, 1988).

(b) *Metallic chromium and chromium alloys*

Chromium (pure) metal is a minor product of the metallurgical processing of chromium. It is available as electrolytic chromium (98.7-99.5% Cr; Elkem Metals Co., 1986), aluminothermic chromium (98.3% Cr (Morning, 1975) and 99.0-99.8% Cr (Delachaux, 1989)) and vacuum aluminothermic chromium (99.5-99.8% Cr; Delachaux, 1989). Electrolytic chromium and aluminothermic chromium typically contain traces of silicon, carbon, phosphorus, sulfur, iron, aluminium, nitrogen, oxygen and hydrogen (Elkem Metals Co., 1986; Belmont Metals, 1989). Chromium metal rapidly forms an oxide layer at the surface in air; such oxidation of finely divided chromium powder can result in the conversion of a large fraction of the metal to metal oxide upon prolonged storage (Sunderman *et al.*, 1974).

Ferrochromiums are the main intermediates in the metallurgical processing of chromium. There are three categories: high-carbon, low-carbon and ferrochromium silicon. The compositions of typical ferrochromiums are given in Table 3 (Morning, 1975).

Chromium-containing steels are usually stainless steels and are iron-base alloys. Some representative analyses of various grades are given in Table 4.

Chromium alloys can be categorized as nickel-chromium, cobalt-chromium and iron-nickel-chromium alloys. Some representative analyses are given in Table 5.

A range of chromium-containing alloys is used for surgical implants. Specifications of the American Society for Testing and Materials for such alloys are given in Table 6.

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Table 3. Composition of typical ferrochromium and chromium metals^a

Grade	Chromium	Silicon	Carbon	Sulfur (max)	Phosphorus (max)
High-carbon	65-70	1-2	5-6.5	0.04	0.03
Charge chromium:					
50-55% chromium	50-55	3-6	6-8	0.04	0.03
66-70% chromium	66-70	3	5-6.5	0.04	0.03
Low-carbon:					
0.025% carbon	67-75	1	0.025	0.025	0.03
0.05% carbon	67-75	1	0.05	0.025	0.03
Ferrochromium-silicon					
36/40 grade	35-37	39-41	0.05	-	-
40/43 grade	39-41	42-45	0.05	-	-

^aFrom Morning (1975)

Table 4. Elemental analysis of representative grades of stainless steel^a

Grade of steel	Elements in presence of iron (weight %)								
	Cr	Ni	Mn	Mo	C	Si	S	P	N
Austenitic									
AISI-201	16.0-18.0	3.5-5.5	5.5-7.5	-	0.15	1.0	0.03	0.06	0.25
AISI-302	17.0-19.0	8.0-10.0	2.0	-	0.15	1.0	0.03	0.05	-
AISI-304	18.0-20.0	8.0-10.5	2.0	-	0.08	1.0	0.03	0.05	-
AISI-316	16.0-18.0	10.0-14.0	2.0	2.0-3.0	0.08	1.0	0.03	0.05	-
Ferritic									
AISI-405	11.5-14.5	-	1.0	-	0.08	1.0	0.03	0.04	-
AISI-430	16.0-18.0	-	1.0	-	0.12	1.0	0.03	0.04	-
AISI-442	18.0-23.0	-	1.0	-	0.20	1.0	0.03	0.04	-
Martensitic									
AISI-403	11.5-13.0	-	1.0	-	0.15	0.50	0.03	0.04	-
AISI-440 A	16.0-18.0	-	1.0	0.75	0.60-0.75	1.0	0.03	0.04	-

^aFrom Nickel Development Institute (1987a)

Table 5. Elemental analyses of representative chromium alloys (weight %)

Alloy	Cr	Ni	Co	Fe	Mo	W	Ta	Nb	Al	Ti	Mn	Si	C	B	Zr
Nickel base															
Cast alloys															
Cast alloy 625	21.6	63.0	-	2.0	8.7	-	-	3.9	0.2	0.2	0.06	0.20	0.20	-	-
Nimocast alloy 263	20.0	55.0	20.0	0.5	5.8	-	-	-	0.5	2.2	0.50	-	0.06	0.008	0.04
Udimet 500	18.0	52.0	19.0	-	4.2	-	-	-	3.0	3.0	-	-	0.07	0.007	0.05
Wrought alloys															
Hastelloy alloy X	22.0	47.0	1.5	18.5	9.0	0.6	-	-	-	-	0.50	0.50	0.10	-	-
Inconel alloy 617	22.0	54.0	12.5	-	9.0	-	-	-	1.0	-	-	-	0.07	-	-
Nimonic alloy PE 16	16.5	43.5	-	34.4	3.2	-	-	-	1.2	1.2	-	-	0.05	0.003	0.04
Cobalt base															
Cast alloys															
Haynes alloy 1002	22.0	16.0	Bal.	1.5	-	7.0	3.8	-	0.3	0.2	0.70	0.40	0.60	-	0.30
WI-52	21.0	-	63.0	2.0	-	11.0	-	2.0	-	-	0.25	0.25	0.45	-	-
Wrought alloy															
Haynes alloy 188	22.0	22.0	39.0	3.0 (max)	-	14.0	-	-	-	-	1.25 (max)	0.40	0.10	-	-
Iron-nickel base															
Wrought alloys															
Haynes alloy 556	22.0	20.0	20.0	29.0	3.0	2.5	0.9	0.1	0.3	-	1.50	0.40	0.10	-	-
Incoloy alloy 800	21.0	32.5	-	46.0	-	-	-	-	0.4	0.4	0.80	0.50	0.05	-	-

^aFrom Nickel Development Institute (1987b); Bal, balance

Table 6. Composition specifications for four representative chromium-containing alloys used in surgical implants (weight %)^a

Alloy	Cr	Mo	Ni	Fe	C	Si	Mn	N	P	S	Ti	W	Co
A	27.0–30.0	5.0–7.0	1.0 max	0.75 max	0.35 max	1.0 max	1.0 max	NA	NA	NA	NA	NA	Balance
B	19.0–21.0	9.0–10.5	33.0–37.0	1.0 max	0.025 max	0.15 max	0.15 max	NA	0.015 max	0.01 max	1.0 max	NA	Balance
C	18.0–22.0	3.0–4.0	15.0–25.0	4.0–6.0	0.05 max	0.50 max	1.0 max	NA	NA	0.01 max	0.5–3.5	3.0–4.0	Balance
D	26.0–30.0	5.0–7.0	1.0 max	0.75 max	0.35 max	1.0 max	1.0 max	0.25 max	NA	NA	NA	NA	Balance

^aFrom American Society for Testing and Materials (1984a, 1987a,b, 1988a)

NA, not applicable

(c) *Chromium [III] compounds*

Basic chromic sulfate is produced by one company in the UK, as 67% basic chromic sulfate and 25-37% sodium sulfate (British Chrome & Chemical Ltd, 1988).

Chromic acetate is available as a 50% green aqueous solution with the following typical analysis; chromium, 11.4%; sulfate, less than 0.2%; chloride, less than 0.1% (McGean-Rohco, 1984).

Chromic chloride hexahydrate is available as a 62% green aqueous solution, typically containing 12% chromium and less than 0.2% sulfate (McGean-Rohco, 1984).

Chromic nitrate is available as a hydrate ($\text{Cr}(\text{NO}_3)_3 \cdot 7.5\text{-}9\text{H}_2\text{O}$) in granules; 12.5-13.5% chromium and as the nonahydrate in liquid form (6.5-10.9% chromium) (McGean-Rohco, 1984).

Chromic oxide is available in several grades depending on its use in metallurgical and refractory industries. A typical analysis of a metallurgical grade is 99.4% chromium (as chromic oxide) and less than 0.1% moisture. A typical analysis of a refractory grade is 98.5-99.4% chromium (as chromic oxide), 0.1% alkali metals (as sodium oxide), 0.1% other metal oxides (mainly aluminium, iron and magnesium), and average particle size, 0.5-3.5 μm (American Chrome & Chemicals, undated a,b,c,d). Chromic oxide pigment (dark chromium oxide) typically contains > 99.0% chromium as chromic oxide (Mineral Pigments Corp., undated a).

Chrome base spinels are part of the family of mixed metal oxide organic coloured pigments. Two such pigments are (i) chromium iron nickel black spinel, the composition of which may include any one or a combination of cupric oxide, manganese oxide and manganese sesquioxide as modifiers, and (ii) chrome manganese zinc brown spinel, which may contain any one or a combination of aluminium oxide, nickel monoxide, silicon dioxide, stannous oxide and titanium dioxide as modifiers (Dry Color Manufacturers' Association, 1982).

Chromic phosphate tetrahydrate is available with a purity of 99.9% (National Chemical Co., undated a).

Analytical reagent-grade *chromium sulfate* hydrate is available with the following impurities: ammonium, 0.01% max; chloride, 0.002% max; insoluble matter, 0.01% max; and iron, 0.01% max. Analytical reagent-grade *potassium chromic sulfate* dodecahydrate is available at a purity greater than 98.0%. Potassium chromic sulfate with various degrees of hydration is available commercially as Chrome Alum Crystal (violet crystals) containing 10% chromium and Chrome Alum 0% Basicity (green powder) containing 15.4% chromium (McGean-Rohco, 1984).

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(d) Chromium[VI] compounds

Ammonium dichromate is available as analytical reagent-grade crystals (99.5%) and as purified-grade crystals and granules with the following impurities: chloride, 0.005% max; fixed alkalis (as sulfate), 0.1-0.2% max; insoluble matter, 0.005% max; and sulfate, 0.005% max.

Calcium chromate is available at a purity of 96% min (Barium & Chemicals, 1988a). When used as a pigment for primer applications, it has the following typical analysis: chromium oxide, 45%; calcium oxide, 44%; chloride, less than 0.001%; sulfate, less than 0.001%; and moisture, 0.01% (National Chemical Co., undated b).

Chromium trioxide is available commercially at a purity of 99.9% (McGean-Rohco, 1984; Occidental Chemical Corp., 1987a; American Chrome & Chemicals, undated e). Two grades available from one company in Europe contain maxima of 20 and 100 mg/kg metallic impurities.

Analytical reagent-grade *potassium chromate* (crystals) is available at a purity of 99.0%. *Potassium dichromate* is available at a purity of 99.8% (Occidental Chemical Corp., 1987b).

Technical-grade anhydrous *sodium chromate* is available at a purity of 99.5% (Occidental Chemical Corp., 1987c). *Sodium dichromate* dihydrate is available at a purity of 100.0% (American Chrome & Chemicals, undated f). Anhydrous sodium dichromate is available at a purity of 99.70% (American Chrome & Chemicals, undated g).

Barium chromate is available at a purity of 98.5-99% (Atomergic Chemetals Corp., 1980; Barium & Chemicals, 1988b; National Chemical Co., undated c).

The term '*zinc chromate*' is a generic term for a series of commercial products with three kinds of molecular structure: (i) '*zinc chromate*' type (like ZnCrO_4); (ii) '*basic zinc chromate*' type (like zinc tetrahydroxychromate ($\text{ZnCrO}_4 \cdot 4\text{Zn}(\text{OH})_2$); and (iii) '(basic) zinc potassium chromate' type (like $3\text{ZnCrO}_4 \cdot \text{Zn}(\text{OH})_2 \cdot \text{K}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$). Several different commercial '*zinc chromates*' are also referred to as '*zinc yellow*'.

Analytical reagent-grade *lead chromate* powder is available at a purity of > 98%. The commercial lead chromate pigments, Primrose Chrome Yellow, Light Chrome Yellow and Medium Chrome Yellow, contain 65-89% lead chromate (Mineral Pigments Corp., undated b,c; National Chemical Co., undated d).

Molybdenum orange is described as a complex of lead molybdate, lead chromate and lead sulfate (National Chemical Co., undated e). One composition comprises 65% lead, 12% chromium and 3% molybdenum (Wayne Pigment Corp., 1985a,b).

Strontium chromate is available at a purity of 99% (National Chemical Co., undated f). A strontium chromate pigment is available with a typical analysis of 41.4% strontium and 46.7-47.3% chromium (Mineral Pigments Corp., undated d).

2. Production, Use, Occurrence and Analysis

The early history of chromium compounds, including synthetic methods used in their preparation, has been reviewed (Mellor, 1931).

2.1 Production

Chromium was first isolated and identified as a metal by the French chemist, Vauquelin, in 1798, working with a rare mineral, Siberian red lead (crocoite, PbCrO_4).

A generalized flow diagram for the production processes used now to lead from chromite ore to the major products containing chromium is shown in Figure 1.

(a) *Chromite ore*

Although chromium is found in various minerals, chromite is the sole source of chromium used commercially (Stern, 1982). From 1797 until 1827, chromite from the Ural Mountains of Russia was the principal source of world supply, primarily for chemical use. After chromite ore was discovered in the USA in 1827, that country became the principal source for the limited world demand; it no longer produces it. Large Turkish deposits were developed in 1860 to supply the world market. Table 7 presents world production figures by region in 1976, 1982 and 1987.

(b) *Metallic chromium and chromium alloys*

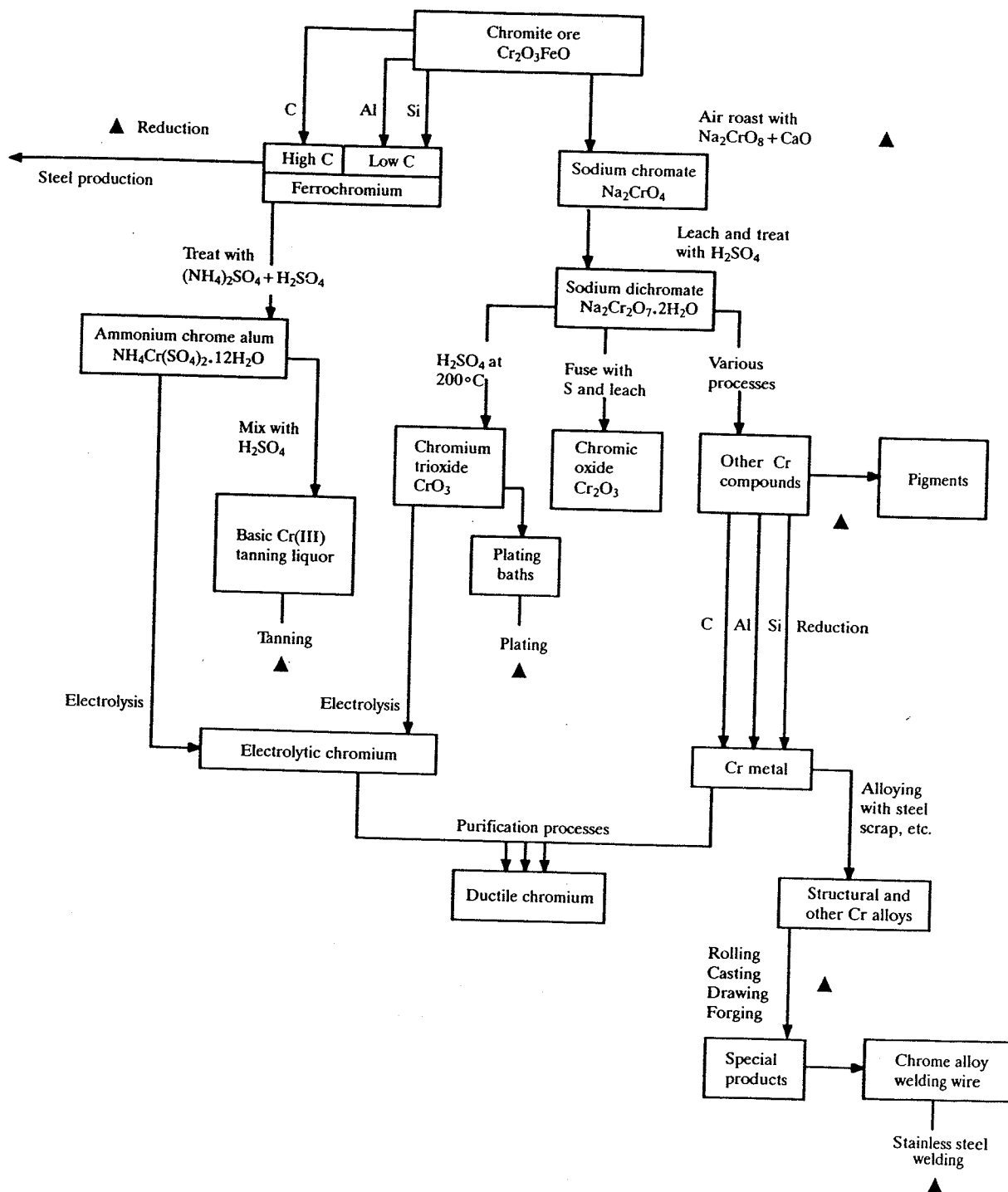
Chromium metal is made commercially in the USA by two processes: (i) an electrolytic method in which a chromium-containing electrolyte, prepared by dissolving a high-carbon ferrochromium in a solution of sulfuric acid and chromium potassium sulfate, is subjected to electrolysis; and (ii) an aluminothermic reduction method in which chromic oxide is reduced with finely divided aluminium (Bacon, 1964; Papp, 1983).

In 1970, US production of chromium metal and metal alloys, other than ferrochromium alloys, was 14 thousand tonnes (about 75% by the electrolytic method; IARC, 1980a); this had increased to 18 thousand tonnes by 1976 (Morning, 1978). Production included chromium briquets, exothermic chromium additives and miscellaneous chromium alloys, in addition to chromium metal. By 1987, US production of chromium metal and ferrochromium-silicon (including exothermic chro-

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Fig. 1. Simplified flow chart for the production of metallic chromium, chromium compounds and selected products from chromite ore. Processes for which occupational exposure levels to chromium are available are indicated by ▲^a



^aFrom Stern (1982)

mium additives and other miscellaneous chromium alloys) had dropped to 1900 tonnes (Papp, 1988).

Table 7. World mine production of chromite ore by region (thousand tonnes)^a

Region ^b	1976	1982	1987
Albania	794	675	830
Brazil	172	276	227
Cuba	32	27	122
Cyprus	9	3	0
Egypt	1	0	0
Finland	414	345	712
France (New Caledonia)	10	50	62
Greece	27	29	64
India	401	364	522
Iran	160	41	56
Japan	22	11	12
Madagascar	221	44	100
Oman	0	0	6
Pakistan	11	4	8
Philippines	427	322	172
South Africa	2409	2431 ^c	3787 ^c
Sudan	22	19	8
Turkey	740	453	599
USSR	2120	2939	3148
Viet Nam	9	16	15
Yugoslavia	2	0	0
Zimbabwe	608	432	540
Total	8611	8481	10 990

^aFrom Morning (1978); Papp (1987, 1988)

^bIn addition to the regions listed, Argentina, Bulgaria, China, Colombia, the Democratic Republic of Korea and Thailand may also have produced chromite ore, but output was not reported quantitatively and available general information was inadequate for formulation of reliable estimates of production.

^cIncludes production by Bophuthatswana

Chromium metal has been produced in Japan since 1956, where it is manufactured by two companies by electrolysis of an ammonium chromic sulfate solution. About 9000 tonnes were produced in 1977; there were no reported imports or exports (IARC, 1980a).

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Ferrochromium is produced by treatment of chromite ore in electric furnaces using coke as a reducing agent. Worldwide production figures for all grades of ferrochromium are summarized in Table 8.

Table 8. World production of ferrochromium (all grades, in thousands of metric tonnes)^a

Country	1983	1985	1987
Albania	35	13	35
Brazil	80	136.2	113.5
Finland	58.7	133	143
France	18.1	0	0
Germany, Federal Republic of	45	70	23
Greece	18.5	45	45
India	53.5	78.5	122.1
Italy	45.4	57.6	59
Japan	329.1	379.7	291
Philippines	27	51	59
South Africa	699.5	851	948
Spain	18	30	17.6
Sweden	119.4	135	110
Turkey	30.1	53.3	54
USA ^b	33	99.7	106.7
USSR	634	415	NA
Yugoslavia	68	73	80
Zimbabwe	140	180	185

^aFrom Chromium Association (1989)

^bIncludes L and HC ferrochromium, FeSiCr, Cr metal and other miscellaneous alloys

NA, not available

Chromium-containing steels (stainless steels and others) are produced by melting cast iron and adding ferrochromium and/or steel scraps in large electric furnaces. The melt is transferred to a refining vessel to adjust the carbon content and impurity levels and is then cast into ingots or continuously into casting shapes. Defects in the cast steel are repaired by cutting or scarfing or by chipping or grinding. The desired shapes are produced primarily by rolling, and their surfaces are conditioned by a variety of operations, including grinding, polishing and pickling (Warner, 1984).

Production figures are given in Table 9.

Chromium alloys are produced by technology very similar to that used for steel production, except that the melting and decarburizing units are generally smaller

and greater use is made of vacuum melting and remelting (Warner, 1984). No data were available on production volumes of these alloys.

Table 9. Stainless-steel production in selected countries^a
(in thousands of metric tonnes)

Country	1987	1988
Austria	54	67
Belgium	182	254
Finland	189	206
France	720	784
Germany, Federal Republic of	957	1186
Italy	550	623
Japan	2722	3161
Spain	327	426
Sweden	457	482
UK	393	427
USA	1840	1995
Yugoslavia	30	30

^aFrom ERAMET-SLN (1989)

Cobalt-chromium alloys were first made in 1907 by fusion of cobalt with 10-60% chromium (Haynes, 1907). Commercial production began shortly thereafter, and since 1920 more than 75% of the cobalt used in the USA has been for the manufacture of alloys with chromium (Sibley, 1976).

Eight US companies produced chromium alloys in 1975, but separate data on the quantity of cobalt-chromium alloys produced were not available (Morning, 1978). Stellite (usually 53% Co, 35% Cr and the remainder tungsten) has been produced by one company in the UK (Roskill Information Services, 1974).

(c) *Chromium [III] compounds*

Solutions of *chromic acetate* are produced by dissolving freshly prepared hydrous chromic oxide in acetic acid (IARC, 1980a). Commercial mixtures of chromic acetate with sodium acetate have been prepared by reduction of sodium dichromate with glucose or corn sugar in the presence of acetic acid (Copson, 1956).

Chromic acetate was produced by five companies in the USA, but no data on volumes were available (IARC, 1980a); it is now produced by one company (Chemical Information Services Ltd, 1988). Annual production in Japan has been about 30 tonnes (IARC, 1980a). Chromic acetate is currently produced by two companies each in Japan and the UK and one each in Australia, Canada and Italy (Chemical Information Services Ltd, 1988).

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Chromic chloride hexahydrate is prepared by dissolving freshly prepared chromium hydroxide in hydrochloric acid. Anhydrous chromic chloride can be produced by passing chlorine over a mixture of chromic oxide and carbon (Sax & Lewis, 1987). Chromic chloride has been produced by two companies in the USA, but no data on volumes were available.

In Japan, chromic chloride has been produced from chromic sulfate by converting it to purified chromic carbonate, which is treated with hydrochloric acid. About 100 tonnes of chromic chloride were produced by one Japanese company in 1977; there were no reported imports or exports. Four companies currently produce chromic chloride in Japan (Chemical Information Services Ltd, 1988).

Chromic chloride is also produced by three companies in the UK, two in the Federal Republic of Germany and one each in Australia and the German Democratic Republic (Chemical Information Services Ltd, 1988).

Chromic hydroxide is produced by adding a solution of ammonium hydroxide to the solution of a chromium salt (Sax & Lewis, 1987). It is produced by one company each in Argentina, Brazil, France, Japan and Turkey, two each in Austria, Spain, the UK and the USA and four in India (Chemical Information Services Ltd, 1988).

Chromic nitrate may be produced by the action of nitric acid on chromium hydroxide (Sax & Lewis, 1987). It is produced by three companies each in Japan, the UK and the USA, two each in Italy and Spain and one in the Federal Republic of Germany (Chemical Information Services Ltd, 1988).

Anhydrous *chromic oxide* is produced commercially by heating chromic hydroxide, by heating dry ammonium dichromate, or by heating sodium dichromate with sulfur and washing out the sodium sulfate (Sax & Lewis, 1987). The hydrated material is made commercially by calcining sodium dichromate with boric acid and hydrolysing chromic borate (IARC, 1980a).

Chromic oxide was produced by six companies in the USA in 1977. US production of the most important type of chromic oxide, chromic oxide green, was reported to be about 6000 tonnes in 1971 (IARC, 1980a), about 3700 tonnes in 1976 and 2700 tonnes in 1977 (Hartford, 1979). It is now produced by one company in the USA (Chemical Information Services Ltd, 1988). Chromic oxide has been produced in Japan by two companies, either by heating hydrous chromic oxide or chromium trioxide or by reducing sodium dichromate with carbon. An estimated 2700 tonnes were produced in 1977 (IARC, 1980a). It is also produced by two companies each in the Federal Republic of Germany and the UK and one each in France, India, Italy, Spain and Switzerland (Chemical Information Services Ltd, 1988).

A violet hexahydrate form of *chromic phosphate* is formed by mixing cold solutions of potassium chromium sulfate (chrome alum) with disodium phosphate. A

green crystalline dihydrate is obtained by boiling the violet hexahydrate with acetic anhydride or by heating it in dry air (Udy, 1956).

Chromic phosphate is produced by two companies in the USA and one each in Australia, Austria, the Federal Republic of Germany, India, Japan and the UK (Chemical Information Services Ltd, 1988).

Solutions of mixed hydrated *chromic sulfates* are obtained by dissolving chromic oxide in concentrated sulfuric acid and allowing it to stand until crystals of the hydrated chromic sulfate separate. The anhydrous form is produced by heating any of the hydrates to 400°C in air or to 280°C in a stream of carbon dioxide (IARC, 1980a). Mixtures of *basic chromic sulfates* (containing mainly $\text{Cr}(\text{OH})\text{SO}_4$) with sodium sulfate are produced commercially by the organic reduction (with such substances as molasses) of a solution of sodium dichromate in the presence of sulfuric acid or by reduction of dichromate solutions with sulfur dioxide (Copson, 1956).

Two companies in the USA produce chromium sulfate and one produces basic chromic sulfate, but no data on volumes were available (Chemical Information Services Ltd, 1988).

Both chromium sulfate and basic chromic sulfate have been produced in Japan since about 1950, by reduction of sodium dichromate with glucose. The combined production of the two producers in 1977 (which are still operating) was about 2000 tonnes basic chromic sulfate and about 120 tonnes chromium sulfate (IARC, 1980a).

Chromium sulfate is also produced by one company each in Brazil, France, India and New Zealand, two each in the Federal Republic of Germany and Spain and three in the UK. Basic chromic sulfate is also produced by one company each in Australia, Brazil, Colombia, Italy, Mexico, Pakistan, Turkey and the USSR, two each in China and India and three in the UK (Chemical Information Services Ltd, 1988).

Potassium chromic sulfate dodecahydrate (potassium chrome alum) is produced commercially by the reduction of potassium dichromate with sulfur dioxide (Copson, 1956). One company in the USA currently produces potassium chromic sulfate, but no data on volumes were available (Chemical Information Services Ltd, 1988). It was produced commercially in Japan before 1940. Production reached about 20-30 tonnes in 1970; subsequently, the annual quantity produced decreased rapidly, and only about one tonne was produced in 1977 (IARC, 1980a).

Potassium chromic sulfate is also produced by one company in Brazil and one company in Czechoslovakia (Chemical Information Services Ltd, 1988).

(d) *Chromium[VI] compounds*

Hexavalent chromium compounds that are commonly manufactured include sodium chromate, potassium chromate, potassium dichromate, ammonium di-

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chromate and chromium trioxide. Other materials that contain chromium[VI] are paint and primer pigments, graphic art supplies, fungicides, wood preservatives and corrosion inhibitors (National Institute for Occupational Safety and Health, 1975). Each chromate-producing process involves the roasting of chromite ore with soda and lime at about 1100°C in a furnace or rotary kiln (Gafafer, 1953). Water-soluble hexavalent chromium compounds do not occur in the ore but comprise part of roast, residue and product materials (Kuschner & Laskin, 1971). The presence of lime ensures that aluminium and silicon oxides in the ore are converted to insoluble compounds, the soluble sodium chromate being recovered by a leaching and crystallization process (National Institute for Occupational Safety and Health, 1975). Chromium trioxide is produced by acidifying the leachate solution with sulfuric acid (Gafafer, 1953). In the manufacture of pigments, chromium trioxide or alkali chromates are reacted with soluble compounds of zinc, lead, iron, molybdenum, strontium and other metals (Stern, 1982). The insoluble precipitates are washed, filtered and dried in the wet department of the processing plant and then ground, blended and packed in the dry departments, where conditions are often dustiest (Gafafer, 1953).

Ammonium dichromate is produced by a crystallization process involving equivalent amounts of sodium dichromate and ammonium sulfate. When low alkali salt content is required, it can be prepared by the reaction of ammonia with chromium trioxide (Hartford, 1979).

Ammonium dichromate is produced by one company each in Argentina, Australia, Brazil, France, Japan, Spain and Switzerland, by two each in the Federal Republic of Germany and India, by four in the USA, and by five in the UK (Chemical Information Services Ltd, 1988).

Calcium chromate is produced commercially by the reaction of calcium chloride with sodium chromate. Hydrated forms can be made, but the anhydrous salt is the only product of commercial significance (IARC, 1980a).

Calcium chromate is currently produced by three companies in the USA, but no data on volumes were available (Chemical Information Services Ltd, 1988). Calcium chromate was formerly produced in Japan at an annual rate of about 100 tonnes, but it has been produced recently in only small amounts for reagent use (IARC, 1980a). It is also produced by one company each in Australia and the UK and two in France (Chemical Information Services Ltd, 1988).

Chromium trioxide is produced commercially by the reaction of sodium dichromate with concentrated sulfuric acid (Hartford, 1979). In 1978, there were two US producers of chromium trioxide, each with a capacity to produce 18 thousand tonnes per year (Anon., 1978). Annual US production in 1977 was in the range of 26 thousand tonnes (Hartford, 1979). In 1988, there were six US producers (Chemical

Information Services Ltd, 1988) with a combined capacity of 52 thousand tonnes per year (Anon., 1988a).

Commercial production in Japan was started before 1940. In 1977, three companies produced a total of 8300 tonnes, of which 1200 tonnes were exported; there were no reported imports (IARC, 1980a). Four companies currently produce chromium trioxide in Japan (Chemical Information Services Ltd, 1988).

Chromium trioxide is also produced by four companies each in the Federal Republic of Germany, India and the UK, three in China, two each in Argentina, Brazil and Mexico and one each in France, Italy, Pakistan, Poland and the USSR (Chemical Information Services Ltd, 1988).

Potassium chromate is produced by the reaction of potassium dichromate with potassium hydroxide or potassium carbonate (Hartford, 1979).

There was one US producer in 1977, but no data on volumes were available; combined US imports of potassium chromate and potassium dichromate in that year were 2.7 tonnes (US Department of Commerce, 1978). There are currently two US producers, but no data on volumes were available (Chemical Information Services Ltd, 1988). Combined US imports of the two compounds in 1985, 1986 and 1987, respectively, were 580, 750 and 1000 tonnes from the UK (52%), the USSR (22%), the Federal Republic of Germany (13%) and Canada (11%); combined US exports for the same years were 64, 19 and 9 tonnes to the Philippines (40%), the Republic of Korea (30%) and Panama (30%) (Papp, 1988).

The two Japanese producers made about one tonne in 1977 for reagent uses; there were no reported imports or exports (IARC, 1980a). One company currently produces potassium chromate in Japan (Chemical Information Services Ltd, 1988). It is also produced by five companies in the UK, four in Brazil, three each in India and Italy, and one each in Argentina, Canada, the Federal Republic of Germany, Spain and Switzerland (Chemical Information Services Ltd, 1988).

Potassium dichromate is produced industrially by roasting chrome ore with potassium carbonate (IARC, 1980a), or, preferably, by reacting sodium dichromate with potassium chloride (Hartford, 1979). Combined US production of potassium dichromate and potassium chromate in 1966 was estimated to be 2600-3800 tonnes, the potassium dichromate believed to be the more important industrially (IARC, 1980a).

Three companies in the USA produce potassium dichromate (Chemical Information Services Ltd, 1988). Current information on imports/exports is given above. Potassium dichromate was first produced commercially in Japan before 1940. Production by two companies in 1978 amounted to about 1000 tonnes, well below the 3200 tonnes level of 1972 and below the 1977 level of 1400 tonnes. Exports are believed to be minor (IARC, 1980a).

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Potassium dichromate is also produced by six companies in India, five in the UK, four in Brazil, two each in the Federal Republic of Germany and Italy, and one each in Argentina, Romania, Spain, Switzerland, Turkey, Yugoslavia and the USSR (Chemical Information Services Ltd, 1988).

Sodium chromate is produced commercially by roasting chromite ore with sodium carbonate, or with sodium carbonate and calcium oxide, and leaching to dissolve the sodium chromate. After treatment to remove hydrated alumina, the sodium chromate solution is either marketed directly or evaporated to produce hydrated or anhydrous crystals (Hartford & Copson, 1964). Sodium chromate may also be produced from sodium dichromate by treatment with sodium hydroxide.

Two companies produced sodium chromate in the USA in 1978. The combined US production of sodium chromate and sodium dichromate increased from 123 thousand tonnes in 1967 to 144 thousand tonnes in 1977 (Hartford, 1979), and was 159 thousand tonnes in 1978. Currently, three companies in the USA have been reported to produce sodium chromate, but data on production volumes were not available (Chemical Information Services Ltd, 1988).

Commercial production in Japan started before 1940. Production in 1977 by the two producing companies was less than 10 tonnes (IARC, 1980a); two companies currently produce this compound (Chemical Information Services Ltd, 1988). It is also produced by five companies in India, four in Brazil, three in the UK, two in the Federal Republic of Germany and one in Spain (Chemical Information Services Ltd, 1988).

Sodium dichromate is produced commercially by the reaction of sulfuric acid with sodium chromate (Hartford, 1979). Three companies in the USA produced this compound in 1976. In 1988, two of five companies that produced it (Chemical Information Sciences Ltd, 1988) had a combined capacity of 144 thousand tonnes per year (Anon., 1988b).

Sodium dichromate was first produced commercially in Japan in about 1908. In 1978, the combined production of two companies was estimated to be 20.7 thousand tonnes, slightly below the 1977 level of 21 thousand tonnes (IARC, 1980a). Three companies currently produce it in that country (Chemical Information Services Ltd, 1988).

Sodium dichromate is also produced by five companies in India, four each in Brazil and the UK, three in China, two each in the Federal Republic of Germany and Turkey, and one each in Argentina, Czechoslovakia, Italy, Mexico, Pakistan, Poland, Romania, Spain, Switzerland and the USSR (Chemical Information Services Ltd, 1988).

Barium chromate is produced commercially by the reaction of barium chloride with sodium chromate (Copson, 1956). Five companies in the USA produced this

chemical in 1977 (IARC, 1980a), and now there are four (Chemical Information Services Ltd, 1988), but no data on volumes were available. Barium chromate is produced by one company in Japan (Chemical Information Services Ltd, 1988). Production in 1977 was estimated to have been less than 50 tonnes; there were no reported imports or exports (IARC, 1980a). It is also produced by four companies in France, two in the UK, and one each in Australia, Austria, Belgium, the Federal Republic of Germany, India, Italy and Spain (Chemical Information Services Ltd, 1988).

Basic lead chromate (Chrome Orange) is produced by the reaction of lead oxide with sodium dichromate in the presence of acetic acid or by the reaction of lead nitrate with sodium chromate in the presence of sodium carbonate (Chalupski, 1956). No information on production of this compound in the USA was available, but combined production of Chrome Yellow and Chrome Orange, containing various proportions of basic lead chromate, amounted to 32.1 thousand tonnes in 1976 and 28.2 thousand tonnes in 1977 (Hartford, 1979). Basic lead chromate is also produced by one company each in Argentina, Colombia, the Federal Republic of Germany, Italy, Japan, Poland and Spain (Chemical Information Services Ltd, 1988).

Lead chromate (Chrome Yellow) can be produced by reacting sodium chromate with lead nitrate, or by reacting lead monoxide with chromic acid solution. By varying the proportion of reactants, either lead chromate (PbCrO_4) or lead chromate oxide (basic lead chromate; $\text{PbO} \cdot \text{PbCrO}_4$) can be produced. High lead chromate content is associated with yellow pigments; increasing the lead chromate oxide content gives orange colours; and mixing with lead molybdate gives red pigments (Chalupski, 1956).

No information on production of this compound in the USA was available, but combined production of Chrome Yellow and Chrome Orange pigments was 32.1 thousand tonnes in 1976 and 28.2 thousand tonnes in 1977 (Hartford, 1979). Assuming an average of 70% lead chromate in these pigments, about 20 thousand tonnes of lead chromate were produced in the USA or imported for use in these pigments in that year. Lead chromate is currently produced by five companies in the USA (Chemical Information Services Ltd, 1988).

Commercial production in Japan was started in about 1910, and there were three major producers and one minor producer in 1977. Production in 1977 was 10.8 thousand tonnes and exports were 1800 tonnes. Six companies currently produce lead chromate in Japan (Chemical Information Services Ltd, 1988). Production of Chrome Yellow in 1984, 1985 and 1986, respectively, was 9900, 8500 and 7900 tonnes (Sasaki, 1985, 1986, 1987).

Lead chromate is also produced by six companies in Spain, five in Italy, three in Belgium, two each in Argentina, Austria, Canada, China, the Federal Republic of

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Germany, France, the Netherlands and Turkey, and one each in Australia, Colombia, Mexico, Poland, Taiwan and the UK (Chemical Information Services Ltd, 1988).

Molybdenum orange pigments are variable complexes of lead sulfate, lead chromate and lead molybdate, made by pouring sodium dichromate, sulfuric acid and sodium molybdate into excess lead nitrate, preferably cold, at pH3. An ageing step is required in precipitation to permit development of the orange tetragonal form (Hartford, 1979).

Molybdenum orange is currently produced by four companies in the USA (Chemical Information Services Ltd, 1988). US imports for 1985, 1986 and 1987, respectively, were 980, 750 and 1100 tonnes from Canada (78%), the Federal Republic of Germany (16%) and Japan (6%) (Papp, 1988). Four companies currently produce molybdenum orange and molybdenum red in Japan (Chemical Information Services Ltd, 1988), and production of molybdenum red in 1984, 1985 and 1986, respectively, was 2900, 2600 and 2200 tonnes (Sasaki, 1985, 1986, 1987).

Molybdenum orange (including molybdenum red) is also produced by one company each in Australia, Austria, Canada, Colombia, India, Italy, Mexico and Taiwan, two each in Belgium, the Federal Republic of Germany, France and the Netherlands and four in Spain (Chemical Information Services Ltd, 1988).

Strontium chromate is prepared by adding a solution of a strontium salt to a solution of sodium chromate (Lalor, 1973).

Production of strontium chromate by three companies in the USA in 1970 was estimated to be 680 tonnes (Lalor, 1973). US imports in 1977 were 242 tonnes, mostly from Canada (US Department of Commerce, 1978). It is currently produced by five companies in the USA, but no data on volumes are available (Chemical Information Services Ltd, 1988). US imports for 1985, 1986 and 1987, respectively, were 390, 120 and 120 tonnes from France (61%), the Federal Republic of Germany (15%) and Canada (11%) (Papp, 1988).

Production in Japan began after 1940. The combined production of three companies in 1977 was about 600 tonnes, comparable with that of the previous seven years; there were no reported imports or exports (IARC, 1980a). Two companies currently produce strontium chromate in that country (Chemical Information Services Ltd, 1988).

Strontium chromate is also produced by four companies in France, two each in Australia, Italy, Spain and the UK and one each in Austria, Belgium, Brazil and the Federal Republic of Germany (Chemical Information Services Ltd, 1988).

Zinc chromates have been produced commercially since about 1940. Basic zinc chromates (including 'zinc chromates') are prepared by reaction between a solution of chromium trioxide and a slurry of zinc oxide. Zinc potassium chromates are pre-

pared by a reaction between a solution of sodium dichromate, a slurry of zinc oxide and a solution of potassium chloride (Lalor, 1973).

Zinc chromate (zinc tetroxychromate) is currently produced by three companies each in Belgium, France, Italy, Japan, Spain and the USA, two each in Argentina and Austria, and one each in Australia, Canada, Colombia, India, the Netherlands, Norway, Poland, Taiwan, Turkey and the UK. Zinc potassium chromate is produced by two companies in Austria, one each in Belgium, France, Italy, Norway, Turkey and the USA (Chemical Information Services Ltd, 1988), and probably elsewhere. Production of 'zinc chromate' in Japan in 1984, 1985 and 1986 was 1530, 1280 and 1000 tonnes, respectively (Sasaki, 1985, 1986, 1987).

(e) *Other chromium compounds*

Chromium carbonyl is produced by the reaction of carbon monoxide with chromic chloride and aluminium metal (IARC, 1980a). Two companies in the USA produce this chemical, but no data on volumes are available. Chromium carbonyl is also produced by one company in the Federal Republic of Germany (Chemical Information Services Ltd, 1988).

2.2 Use

An early use of chromium compounds was as pigments, particularly chrome yellow. Basic chromic sulfate was used in tanning hides, as the reaction of chromium with collagen raises the hydrothermal stability of the leather and renders it resistant to bacterial attack. The most important use of chromium, namely as an alloying element, developed gradually during the nineteenth century and led to the introduction of chromium steels (Westbrook, 1979).

Chromium is currently used in such widely diversified products as stainless, tool and alloy steels, heat- and corrosion-resistant materials, special purpose alloys, alloy cast iron, pigments, metal plating, leather tanning, chemicals, and refractory materials for metallurgical furnaces. It is used in the metallurgical industry to enhance such properties as hardenability (response to quenching), creep (unit stress that will produce plastic deformation at a specified rate and temperature), strength and impact strength and resistance to corrosion, oxidation, wear and galling; its major use is in the production of stainless steel. Chromium pigments represent the largest use of chromium in the chemical industry (Papp, 1983).

(a) *Chromite ore*

Use of chromite ore in the USA decreased from 1.3 million tonnes in 1974 to 912 thousand tonnes in 1976, when utilization by the three consuming industries was as follows: metallurgical, 59.3%; refractory, 20.1%; and chemical, 20.6% (Morning, 1978). US consumption of chromite ore (and concentrate) was 504 thousand tonnes

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in 1987, 91% of which was used by the chemical and metallurgical industries and 9% by the refractory industry (Papp, 1988).

The metallurgical grade is used primarily to produce ferrochromium alloys, which are used in the production of stainless and other special steels (Bacon, 1964). The major use of chromite refractory materials in 1974 was in iron and steel processing, nonferrous alloy refining, glass making and cement processing (Morning, 1975); in 1987, the primary use was in refractory bricks to line metallurgical furnaces (Papp, 1988). Chemical-grade chromite ore is converted (by a series of operations involving roasting with soda ash and/or lime and leaching, with appropriate control of acidity) to sodium dichromate, used as such and in the production of many other chromium chemicals (Copson, 1956).

The major use of chromite ore in Japan has been in the production of ferrochromium (90%), the balance being used in the manufacture of refractory materials (6%), chromium compounds (3%) and chromium metal (1%) (IARC, 1980a).

(b) *Metallic chromium and chromium alloys*

Chromium metal (pure) is used to prepare alloys with high purity specifications. Chromium is thus an important and widely used alloying element in ferrous and nonferrous alloys, including those based on nickel, iron-nickel, cobalt, aluminium, titanium and copper. In alloys based on nickel, iron-nickel and cobalt, chromium is used primarily to confer oxidation and corrosion resistance. In alloys of aluminium, titanium and copper, chromium is used to control microstructure. Stainless steel contains at least 12% and may contain up to 36% chromium. Chromium-containing tool steels contain 1-12% chromium. Most full alloy steels contain 0.5-9% chromium, but some grades contain up to 28%. Cast irons contain 0.5-30% chromium (Papp, 1983).

In 1976, 70% (170 thousand tonnes) of all US chromium metal and metal alloys were used in the production of stainless steel. Of the total of chromium metal and alloys used in the production of commercial alloys, about 60% was in high-carbon ferrochromium, 11% in low-carbon ferrochromium, 21% in ferrochromium-silicon and 7.4% in other alloys, chromium briquets, exothermic additives and chromium metal (Morning, 1978). In 1987, 82% (330 thousand tonnes) of all US chromium ferroalloys, metal and other chromium-containing materials were used in the production of stainless steel. Of the total of chromium metal and alloys used in the production of commercial alloys, about 88% was in high-carbon ferrochromium, 6.5% in low-carbon ferrochromium, 4% in ferrochromium-silicon, 0.5% in other alloys and 1% in chromium metal (Papp, 1988).

Chromium-containing steels are widely used in, for instance, general engineering, architectural panels and fasteners, pollution control equipment, chemical

equipment, cryogenic uses, hospital equipment, domestic equipment, automotive parts, engine components and food processing (Eurométaux, 1986).

Chromium alloys are used in a large variety of applications, including jet engine parts, nuclear plants, high-temperature reaction vessels, chemical industry equipment, high temperature-resistant equipments, coinage, desalinization plants, ships' propellers, acid-resistant equipment, cutting tools and implants (National Research Council, 1974).

Cobalt-chromium alloys were originally developed for use in cutting tools. Subsequently, because of their corrosion resistance, they were also used for equipment in contact with acids and other chemicals. They are used for facing valves and seats in internal combustion engines; wearing surfaces or cutting edges of hot shears, trimming dies, cam gauges, punches and turbine blades; pipeline linings; and pumps for corrosive liquids (Cobalt Development Institute, 1985). Stellite alloys are used in high-temperature applications. The superalloys are used for turbine discs and blades and nozzle vanes in jet engines; grates and quenching baskets in furnaces; and high-temperature springs and fasteners (Roskill Information Services, 1974). Vitallium alloy (27 wt% Cr, 5% Mo, 0.5% C, balance Co) is most commonly used as a denture alloy (Sullivan *et al.*, 1970).

(c) *Chromium[III] compounds*

Chromic acetate is used in printing and tanning, as a textile mordant, a polymerization and oxidation catalyst, and an emulsion hardener (Hartford, 1979; Sax & Lewis, 1987). Most of the chromic acetate produced in Japan has been used in dyeing processes (IARC, 1980a).

Chromic chloride is used for the production of commercial solutions of the basic chlorides ($\text{Cr}(\text{OH})_2\text{Cl}$) by reaction with sodium hydroxide. These solutions have been reported to have minor special applications, such as use as a mordant for alizarin dyes on cotton yarn and certain cyamine dyes on silk. In Japan, they are also used for decorative chromium plating (IARC, 1980a).

Anhydrous chromic chloride has been used as a catalyst for polymerizing olefins, for chromium plating (including vapour plating), for preparing sponge chromium and other chromium salts, as an intermediate, and for waterproofing (Sax & Lewis, 1987).

Chromic hydroxide has been used as a catalyst, a tanning agent, a mordant, and in the preparation of Guignet's green (hydrated chromic oxide green) (Sax & Lewis, 1987).

Chromic nitrate has been used as a catalyst and a corrosion inhibitor (Sax & Lewis, 1987). It has also been used in textiles and in the manufacture of chromium dioxide (Hartford, 1979).

Most *chromic oxide* (anhydrous and hydrated) is used as a pigment. A substantial portion is also used in metallurgy in the manufacture of chromium metal and aluminium-chromium master alloys and, to a lesser extent, as a catalyst, in refractory brick, and as a chemical intermediate (IARC, 1980a; Sax & Lewis, 1987).

Anhydrous chromic oxide is the most stable green pigment known and is used in applications requiring resistance to heat, light and chemicals (e.g., in glass and ceramics). It is used in dyeing polymers, and its resistance to alkali makes it a valuable colourant for latex paints. It has special use in colouring cement and granules for asphalt roofing and in camouflage paints. Metallurgical-grade anhydrous chromic oxide is used in the manufacture of chromium metal and aluminium-chromium master alloys. It is used as a catalyst in the preparation of methanol, butadiene and high-density polyethylene. Chromic oxide is also used in refractory brick as a minor component to improve performance. When used as a mild abrasive for polishing jewellery and fine metal parts, it is known as 'green rouge' (IARC, 1980a).

Hydrated chromic oxide is also used as a green pigment, especially for automotive finishes (IARC, 1980a).

In Japan, chromic oxide has been used for the production of refractory materials (36%), pigments (35%), abrasives (15%) and other uses, such as glaze for glass (14%) (IARC, 1980a).

Chromic phosphate is used in pigments, phosphate coatings and wash primers, and as a catalyst (Hartford, 1979; Sax & Lewis, 1987).

Chromic sulfate is used in chrome plating, chromium alloys, green paints and varnishes, green inks, ceramic glazes, and as a mordant for textile dyeing. Basic chromic sulfate is the principal chemical used in leather tanning (Sax & Lewis, 1987).

Potassium chromic sulfate (chrome alum) has been reported to be used as a mordant prior to application of mordant dyes. It is also used to treat cotton that has been dyed with certain direct cotton dyes and sulfur dyes, rendering the dyed textile faster to washing. Another important application is in the preparation of hydrous chromic oxide, which, in turn, is used to make many of the trivalent chromium mordants (Howarth, 1956). It has also been used in chrome-tan liquors for tanning, in photographic fixing baths, and in ceramics (Sax & Lewis, 1987).

(d) *Chromium[VI] compounds*

Ammonium dichromate has a variety of uses, including a mordant for dyeing; in pigments; in the manufacture of alizarin, potassium chromic sulfate and catalysts; in oil purification; in pickling; in leather tanning; in synthetic perfumes; in photography; in process engraving and lithography; and in pyrotechnics (Sax & Lewis, 1987).

Calcium chromate is largely used as a corrosion inhibitor and as a depolarizer in batteries (Hartford, 1979). Its addition to protective coatings for steel and light metals is sometimes reported as a pigment use, but its primary function in these products is to inhibit corrosion. It is also used in ceramics and in paint pigments (Barium & Chemicals, undated). The use of calcium chromate as a pigment was discontinued in Japan some years ago (IARC, 1980a).

A major use of *chromium trioxide* has been in chromium plating, particularly in the production of automobiles. Uses in other metal-finishing operations include aluminium anodizing, particularly on military aircraft; chemical conversion coatings, which provide both decoration and corrosion protection; and the production of phosphate films on galvanized iron or steel (IARC, 1980a). Other uses of chromium trioxide are as a wood preservative (Anon., 1988a), as a corrosion inhibitor for ferrous alloys in recirculating water systems, as an oxidant in organic synthesis and in catalyst manufacture. Small amounts are used to modify the properties of basic magnesite refractories (IARC, 1980a).

US demand for chromium trioxide was 31.5 thousand tonnes in 1978 (Anon., 1978) and 57 thousand tonnes in 1988 (Anon., 1988a). The pattern of use in the USA in 1978 was as follows: metal treating and plating, 80%; wood treatment, 10%; chemical manufacturing, 5%; and other, 5% (Anon., 1978). The pattern of use in the USA in 1988 was: wood treatment, 63%; metal finishing, 22%; other (including water treatment, magnetic particles and catalysts), 7% (Anon., 1988a).

In Japan, the major use of chromium trioxide (90%) has been in chromium plating; 3% is used in pigments and 7% in other uses such as abrasives. The total used in Japan dropped from 11 800 tonnes in 1972 to 8300 tonnes in 1977 (IARC, 1980a).

Potassium chromate has limited applications in the textile industry — when a potassium rather than a sodium salt is essential or when differences in solubility or other physical properties make its use desirable (Howarth, 1956). Among these uses are as a mordant for wool, in dyeing nylon and wool with mordant acid dyes, in oxidizing vat dyes and indigosol dyes on wool, in dyeing with chromate colours, in treating direct dyes and some sulfur dyes on cotton to render them faster to washing, in oxidizing aniline black, and in stripping dyed wool (IARC, 1980a).

Potassium dichromate was once the most important commercial chromium compound, but it has largely been replaced in many applications by sodium dichromate. It is used in many small-volume applications such as photomechanical processing, chrome-pigment production and wool preservative formulations. The major use for potassium dichromate in Japan has been pigment production (54%); dye manufacture consumes an estimated 22%, with the remaining 24% used as an oxi-

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dizing agent in miscellaneous uses (as a catalyst and in other applications) (IARC, 1980a).

Sodium chromate is used in inks, leather tanning, wood preservation, corrosion inhibition, as a pigment in paint, water treatment, drilling muds, textile dyeing, cutting oils, catalysts, and as a raw material for the production of other chromium compounds (Sax & Lewis, 1987; American Chrome & Chemicals, undated h,i). In Japan, its principal use is as a mordant in dyeing operations (IARC, 1980a).

Sodium dichromate is the primary base material for the manufacture of chromium chemicals, which are used in leather tanning, metal treatment, drilling muds, textile dyes, catalysts, and wood and water treatment (Papp, 1983).

Demand for sodium dichromate in the USA was 146 thousand tonnes in 1978 (Anon., 1979) and 149 thousand tonnes in 1988 (Anon., 1988b). The pattern of use in 1978 was as follows: manufacture of chromium trioxide, 28%; manufacture of pigments, 24%; manufacture of leather tanning chemicals, 17%; corrosion control, 7%; metal treatment, drilling muds and textiles, 8%; and other (including chemical manufacture, catalysts, and wood preservation), 8% (Anon., 1979). The pattern of use in the USA in 1988 was as follows: manufacture of chromium trioxide, 54%; leather tanning, 9%; manufacture of chromium oxide, 9%; manufacture of pigments, 8%; wood preservation, 5%; and other (including drilling muds, catalysts, water treatment and metal finishing), 5% (Anon., 1988b).

Barium chromate is used in pyrotechnics, in high-temperature batteries, in safety matches, as a corrosion inhibitor in metal-joining compounds, as a pigment in paints, in ceramics, in fuses, in metal primers, and in ignition control devices (Hartford, 1979; Sax & Lewis, 1987). In Japan, the principal use was reported to be in explosive fuses (IARC, 1980a).

Chrome orange pigments, consisting largely of basic lead chromate, have been widely used in paints, metal protective primers and linoleum (Chalupski, 1956). In the early 1970s, use of chrome oranges in the USA was decreasing, although they were still being used in tints and rust-inhibiting paints (Schiek, 1973).

Lead chromate is used to make pigments for paints to be applied to both wood and metal. Chrome yellows (containing 52-98% lead chromate) are considered to be the most versatile of the inorganic pigments and are therefore found in many formulations designed for a wide spectrum of uses. The largest use of chrome yellows in the early 1970s was in paint for automotive finishes, farm machinery, architectural and air-dried finishes, and water-thinned coatings for exterior and interior use. Medium chrome yellow paints make up about 30% of the paint used for traffic control. Chrome yellows are also used as colourants in vinyls, rubber and paper. The second largest use of chrome yellows is in printing inks (Schiek, 1973).

The major use for lead chromate in Japan is in the production of pigments for paint and inks (85%); other uses are as a colourant for synthetic resins (14%) and miscellaneous applications (1%) (IARC, 1980a).

Molybdenum orange pigments are used in coatings, inks and plastics (National Chemical Company, undated e).

Strontium chromate was first used commercially (near the end of the nineteenth century) as a colourant in artists' paints, under the name 'citron yellow'. It was replaced for this use by organic pigments in 1936, at which time it was also being used for corrosion resistance on aluminium and magnesium alloys. Later, it was used in chemical-resistant coatings because of its low reactivity, and in epoxy polyamide vehicles and vinyl sheeting because of its heat-resistant properties. In 1973, some strontium chromate was still being used in vinyl sheeting and chemical-resistant coatings and in primer coatings for water tanks, but most of it was used, either alone or in combination with basic zinc chromate, in wash primers or in aluminium flake coatings (Lalor, 1973). Strontium chromate has also been used as an additive to control the sulfate content of solutions in electrochemical processes (Hartford & Copson, 1964). In Japan, the only known use has been as a corrosion inhibitor (IARC, 1980a).

Zinc chromates are used as pigments in paints, varnishes and oil colours. Many of them are used as a corrosion-resisting primer coatings and in metal conditioners (wash primers) applied before priming; in this case, they are used more for their chemical characteristics than their hue (Lalor, 1973; Windholz, 1983).

(e) *Other chromium compounds*

Chromium carbonyl has reportedly been used as an isomerization and polymerization catalyst, as a gasoline additive, and as a chemical intermediate (Sax & Lewis, 1987). It has also been used in the synthesis of 'sandwich' compounds (Hartford, 1979) from aromatic hydrocarbons, such as dibenzene(chromium) from benzene. Some of these compounds have been investigated as possible sources of vapour-deposited chromium and for the production of carbides.

2.3 Occurrence

The occurrence and distribution of chromium in the environment has been reviewed (Sayato & Nakamuro, 1980; Sequi, 1980; Balsberg-Påhlsson *et al.*, 1982; Cary, 1982; Filiberti *et al.*, 1983; Fishbein, 1984; Gaughhofer, 1984; Jin & Hou, 1984; Barceló *et al.*, 1986; Poschenrieder *et al.*, 1986; Camusso & Montesissa, 1988; Nriagu & Nieboer, 1988).

(a) *Natural occurrence*

Chromium is widely distributed in the earth's crust but is concentrated in the ultrabasic rocks. At an overall crust concentration of 125 mg/kg Cr (National Re-

search Council, 1974), it is the twentieth most abundant element, ranking with vanadium, zinc, nickel, copper and tungsten (Westbrook, 1979). Only the trivalent and hexavalent compounds are detected in the environment in significant quantities (Fishbein, 1976). In reducing environments, chromium[VI] is unstable relative to chromium[III]. The average concentration of chromium in basalt, shale and granite has been reported to be 200, 100 and 20 ppm (mg/kg), respectively. The world average concentration of chromium in ultramafic, mafic, intermediate and felsic rock has been reported to be 2000, 200, 50 and 25 ppm (mg/kg), respectively. Concentrations in rock samples from Hawaiian lavas, from the Skaergaard intrusion in Greenland and from tertiary lavas of northeastern Ireland ranged from less than 1 ppm to 1750 ppm (mg/kg) chromium (Cary, 1982).

Chromium is found in nature only in the combined state and not as the free metal. It exists mainly as chromite, which has the idealized composition $\text{FeO} \cdot \text{Cr}_2\text{O}_3$, although this composition has been found in nature only in meteorites. Chromite is a mixed metal oxide spinel containing iron, chromium, magnesium and aluminium in various proportions (Hartford, 1963) and as such is found in considerable quantities in Zimbabwe, the USSR, South Africa, New Caledonia and the Philippines (National Research Council, 1974; World Health Organization, 1988); it contains 40-50% chromium (Bidstrup & Case, 1956).

Of the chromium chemicals (other than chromite ore) included in this monograph, only two are known to occur in nature in mineral form: lead chromate as crocoite and potassium dichromate as lopezite (Hartford, 1963).

(b) *Occupational exposures*

Occupational exposures to a number of specific chromium compounds have been reported. With respect to hexavalent compounds, the most important exposures are to sodium, potassium, calcium and ammonium chromates and dichromates during chromate production, to chromium trioxide during chrome plating, to insoluble chromates of zinc and lead during pigment production and spray painting, to water-soluble alkaline chromates during steel smelting and welding and to other chromates during cement production and use. Trivalent compounds that are common in work place air include chromite ore during chromate production and in the ferrochromium industry, chromic oxide during pigment production and use, and chromic sulfate during leather tanning. In addition, occupational exposures to airborne dusts containing chromium metal may occur during production, welding, cutting and grinding of chromium alloys (Stern, 1982; Nieboer *et al.*, 1984; World Health Organization, 1988; see the monograph on welding, pp. 463-474). A schematic diagram of the production processes for some important commercial chromium compounds was given in Figure 1, on which those operations for which exposure data are available are indicated.

Potential occupational exposure to chromium occurs through inhalation, ingestion or skin contact (National Research Council, 1974). The US National Institute for Occupational Safety and Health (1977) estimated that about two million workers are exposed to chromium and chromium compounds. Chromium ulcers or chromate dermatitis, which are indicative of occupational exposure, have been reported in numerous occupations, involving manual handling of cement, leather, plastics, dyes, textiles, paints, printing inks, cutting oils, photographic materials, detergents, wood preservatives, anticorrosion agents and welding rods (Pedersen, 1982; Burrows, 1983; Polak, 1983; Nieboer *et al.*, 1984; Table 10; see also section 3.3(b), p. 182).

Table 10. Occupations with potential exposure to chromium^a

Abrasives manufacturers	Jewellers
Acetylene purifiers	Laboratory workers
Adhesives workers	Leather finishers
Aircraft sprayers	Linoleum workers
Alizarin manufacturers	Lithographers
Alloy manufacturers	Magnesium treaters
Aluminium anodizers	Match manufacturers
Anodizers	Metal cleaners
Battery manufacturers	Metal workers
Biologists	Milk preservers
Blueprint manufacturers	Oil drillers
Boiler scalers	Oil purifiers
Candle manufacturers	Painters
Cement workers	Palm-oil bleachers
Ceramic workers	Paper waterproofers
Chemical workers	Pencil manufacturers
Chromate workers	Perfume manufacturers
Chromium-alloy workers	Photoengravers
Chromium-alum workers	Photographers
Chromium platers	Platinum polishers
Copper etchers	Porcelain decorators
Copper-plate strippers	Pottery frosters
Corrosion-inhibitor workers	Pottery glazers
Crayon manufacturers	Printers
Diesel locomotive repairmen	Railroad engineers
Drug manufacturers	Refractory-brick manufacturers
Dye manufacturers	Rubber manufacturers
Dyers	Shingle manufacturers
Electroplaters	Silk-screen manufacturers
Enamel workers	Smokeless-powder manufacturers
Explosives manufacturers	Soap manufacturers

Table 10 (contd)

Fat purifiers	Sponge bleachers
Fireworks manufacturers	Steel workers
Flypaper manufacturers	Tanners
Furniture polishers	Textile workers
Fur processors	Wallpaper printers
Glass-fibre manufacturers	Wax workers
Glass frosters	Welders
Glass manufacturers	Wood-preservative workers
Glue manufacturers	Wood stainers
Histology technicians	

“From National Research Council (1974)

This section summarizes data on exposure to chromium in air and the results of biological monitoring in various industries and occupations. The biological indicator levels are influenced by the solubility of chromium compounds and by the time of sampling. It should be noted that the chromium compounds, the timing of collection of biological samples (normally at the end of a shift) and the analytical methods used differ from study to study, and elevated levels of chromium in biological fluids and tissue samples are mentioned only as indications of uptake of chromium. (See also section 3.3(b) and the monographs on nickel and nickel compounds, and on welding.)

(i) *Ferrochromium steel and high chromium alloy production*

During the electrothermal reduction of chromite ore with coke for the production of ferrochromium, workers in the area near the furnaces are exposed to fumes containing 0.1-10% chromium (Stern, 1982).

In 1959, an industrial hygiene survey was carried out in a US plant producing ferrochromium, ferrosilicon and chromium alloys in electric furnaces. The mean concentrations of chromium trioxide [values for chromium calculated by the Working Group in square brackets] in the air were 1 [< 1] $\mu\text{g}/\text{m}^3$ in the maintenance shop, 266 [140] $\mu\text{g}/\text{m}^3$ in the charging area, 317 [160] $\mu\text{g}/\text{m}^3$ in the casting area and 2470 [1300] $\mu\text{g}/\text{m}^3$ in the finishing area. The overall mean of 127 samples was 452 $\mu\text{g}/\text{m}^3$ chromium trioxide [230 $\mu\text{g}/\text{m}^3$ chromium] (Princi *et al.*, 1962).

In 1973, workplace concentrations of hexavalent chromium were reported to be 30-60 $\mu\text{g}/\text{m}^3$ during the production of ferrochromium in the USSR (World Health Organization, 1988).

Concentrations of total dust and chromium in 1975 in a Norwegian ferrochromium plant are shown in Table 11. In various occupations, the mean level of total

Table 11. Air concentrations of total dust and chromium in a Norwegian ferro-chromium plant^a

Occupation or area	No. of samples	Mean and range of dust concentration (mg/m ³)	Mean and range of chromium concentration (µg/m ³)
Potmen	20	6.3 (4.0-15.7)	40 (20-70)
Cleaner-balers	5	18.2 (10.5-23.9)	90 (50-130)
Crane drivers	10	4.6 (3.1-7.6)	40 (10-50)
Packers	10	4.9 (2.3-8.3)	290 (50-1300)
Maintenance workers	9	15.6 (4.0-46.0)	90 (20-370)
Transport workers	9	12.8 (5.6-30.1)	10 (10-30)
Charge floor	5	4.8 (2.8-8.4)	50 (30-70)
Top electrode	3	15.5 (13.9-17.8)	170 (150-190)
Packing area	18	1.9 (0.3-5.5)	190 (10-1340)

^aFrom Langård *et al.* (1980)

chromium was 10-290 µg/m³, about 11-13% of which was water-soluble (Langård *et al.*, 1980).

Among Swedish ferrochromium workers, exposure to hexavalent chromium was estimated at 250 µg/m³ during arc-furnace operations and 10-50 µg/m³ during transport, metal grinding, maintenance and sample preparation. The total concentration of metallic and trivalent chromium at the work sites was 500-2500 µg/m³ (Axelsson *et al.*, 1980).

In an Italian ferrochromium plant, dust samples contained 0.9-3.8% chromium, and airborne levels of total chromium were 20-158 µg/m³. The concentration of hexavalent chromium was below 1 µg/m³. Levels of urinary chromium measured at the beginning and end of a work shift were low (less than 5 µg/g creatinine), although the results indicated absorption of chromium in some groups of workers (Foa *et al.*, 1988).

In ten steel, 15 iron and 11 copper alloy foundries in Finland in 1973 and 1974, furnacemen and casters were exposed to a mean level of 1-6 µg/m³ acid-soluble chromium (Tossavainen, 1976).

During the production of chromium carbide powder in the USSR, dust concentrations were 11-20 mg/m³ during weighing of chromium[III] oxide, 260-640 mg/m³ during milling and 24-200 mg/m³ during loading, screening and packing of the product (Brakhnova, 1975). In open-hearth steel works, concentrations of chromium trioxide in work place air were 13-37 µg/m³ [7-20 µg/m³ chromium] (Belitskaya, 1981).

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In Sweden, the tissue concentrations of chromium in the lungs of 20 deceased smelter workers were three to four times higher than those of eight control subjects (median level, 0.29 and 0.08 µg/g wet tissue, respectively) (Brune *et al.*, 1980).

In Finland, fumes and dusts contained 6-15% chromium during ferrochromium smelting, 1.5-5% during stainless-steel smelting, 0.2-0.3% during continuous casting and 1.6-13% during grinding of stainless steel (Koponen *et al.*, 1981). Air concentrations of total chromium were 200 µg/m³ during ferrochrome smelting and 10 µg/m³ during continuous casting of stainless steel. The mean concentration of hexavalent chromium during the production of stainless steel was 1.5 µg/m³ (Koponen, 1985).

In France, air concentrations of total chromium ranged from 15 to 300 µg/m³ in a steel production plant (Klein, 1985).

Triebig *et al.* (1987) measured the exposure of 230 workers in high-alloy steel plants to chromium in the Federal Republic of Germany. Levels of chromium trioxide [chromium] in the air were 10-2280 [5-1200] µg/m³. Urinary levels of chromium were 0.1-79 µg/g creatinine, indicating some exposure to metal fumes and dusts in steel smelting, cutting and grinding.

(ii) *Production of chromates and of chromate pigments*

Airborne concentrations of chromates [chromium] in four US chromate plants over the period 1941-47 were 10-4600 [5-2300 µg/m³] at kilns and mills, 40-340 [20-170] µg/m³ at dryers, 200-21 000 [100-11 000] µg/m³ in packing areas and 3-2170 [2-1100] µg/m³ in other parts of the factories (Machle & Gregorius, 1948). Workplace air concentrations of chromium[III], chromium[VI] and total chromium during various operations in chromite ore processing were reported for a plant in Ohio (USA) which produced sodium dichromate (Bourne & Yee, 1950) and for a chromate production plant in the UK (Buckell & Harvey, 1951; see Table 12).

Table 12. Air concentrations of chromium[III] and chromium[VI] in US^a and UK^b chromate factories

Operation	Chromium[III] (mg/m³)		Chromium[VI] (mg/m³)	
	USA	UK	USA	UK
Chromite and lime mixing	1.52	2.14	0.03	0.005
Roasting	0.39	0.17	0.26	0.029
Filtering	0.12	0.037	0.08	0.52
Shipping	0.30	0.005	0.2	0.88

^aFrom Bourne & Yee (1950)

^bFrom Buckell & Harvey (1951)

In a chromate production plant in the USA, the levels of water-soluble hexavalent chromium were 100-900 $\mu\text{g}/\text{m}^3$ in 1945-49 and 5-100 $\mu\text{g}/\text{m}^3$ in 1950-59 (Braver *et al.*, 1985). In 1953, the US Public Health Service studied the health hazards associated with the chromate-producing industry. Six plants were directly involved in the production of alkaline chromates and dichromates from chromite ore. One of the plants also manufactured chromium pigments. In about 1600 air samples, the weighted average exposures by occupational groups were 7-890 $\mu\text{g}/\text{m}^3$ insoluble chromium as chromite, 5-170 $\mu\text{g}/\text{m}^3$ water-soluble chromium[VI] and 10-470 $\mu\text{g}/\text{m}^3$ acid-soluble, water-insoluble chromium (Gafafer, 1953).

Concentrations of soluble and acid-insoluble chromium in lung tissues of 16 chromate manufacturing workers in the USA ranged from 3 to 161 $\mu\text{g}/\text{g}$ dry tissue and 5 to 402 $\mu\text{g}/\text{g}$ dry tissue, respectively; the workers had been exposed to chromite ore, sodium chromate, potassium dichromate and various intermediate chromium compounds for 1.5-42 years (Baetjer *et al.*, 1959a).

In Italy, chromic acid and alkaline chromate production workers were exposed to mean levels of 110-150 $\mu\text{g}/\text{m}^3$ chromates [60-80 $\mu\text{g}/\text{m}^3$ hexavalent chromium] (Vigliani & Zurlo, 1955). More recently, dust exposures and urinary excretion of chromium were studied in another Italian factory that produces potassium dichromate and chromic sulfate. A group of 22 potassium dichromate workers was exposed to levels of 10-100 $\mu\text{g}/\text{m}^3$ chromium[III] and 8-212 $\mu\text{g}/\text{m}^3$ water-soluble chromium[VI] (Mutti *et al.*, 1984), and their mean urinary concentration of total chromium was 31.5 $\mu\text{g}/\text{l}$ (Cavalleri & Minoia, 1985). A group of 15 chromic sulphate workers were exposed to levels of 46-1689 $\mu\text{g}/\text{m}^3$ chromium[III] and 2-23 $\mu\text{g}/\text{m}^3$ chromium[VI] (Mutti *et al.*, 1984); their urinary chromium concentrations averaged 24.7 $\mu\text{g}/\text{l}$. Chromium levels in serum and erythrocytes were also increased among exposed workers (Cavalleri & Minoia, 1985).

In Japan, air concentrations of total chromium during sodium and potassium dichromate and chromium trioxide production in one plant ranged from 19 to 219 $\mu\text{g}/\text{m}^3$; in 1960, levels of chromium trioxide [chromium] were 390-20 170 [180-10 000] $\mu\text{g}/\text{m}^3$ in this factory, where enclosures and local exhausts were not properly used. Chromium content was measured in several organs of six chromate workers who had been exposed for over ten years and had died of lung cancer; the chromium concentration in the lungs averaged 51.1 $\mu\text{g}/\text{g}$ wet weight, while in unexposed controls it averaged 0.31 $\mu\text{g}/\text{g}$ wet weight (Kishi *et al.*, 1987). In six Japanese studies, the chromium contents of the lungs of chromate workers were 0.5-132 $\mu\text{g}/\text{g}$ wet weight and 14-2368 $\mu\text{g}/\text{g}$ dry weight, as compared to 0.05-3.72 $\mu\text{g}/\text{g}$ wet weight and 0.47-5.14 $\mu\text{g}/\text{g}$ dry weight in men without occupational exposure (Adachi, 1987). High concentrations of chromium were found in the respiratory organs of chromate workers who had died of cancer, and in the spleen, liver, kidney, brain, heart, bone marrow

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and skin (Hyodo *et al.*, 1980; Teraoka, 1987). In 1957, chromium trioxide [chromium] concentrations in the plant ranged from 40-8430 [20 to 4300] $\mu\text{g}/\text{m}^3$, with a mean of 520 [260] $\mu\text{g}/\text{m}^3$ (Hyodo *et al.*, 1980).

Chromate pigment workers are exposed primarily to zinc and lead chromates although they may also be exposed to other compounds, such as chromium trioxide, sodium chromate and dichromate and zinc oxide (Davies, 1984a).

In three Norwegian pigment plants producing zinc and lead chromates, workers mixing raw materials and filling sacks were exposed to mean concentrations of 1.2-9.8 mg/m^3 total dust and 10-1350 $\mu\text{g}/\text{m}^3$ chromium. The chromium levels to which foremen are exposed were taken as a measure of general exposure in the plants; in one plant it was 40 $\mu\text{g}/\text{m}^3$, in another it was 190 $\mu\text{g}/\text{m}^3$ (Langård & Norseth, 1975).

In India, the concentration of chromium in the urine of workers exposed to chromates in two paint manufacturing factories was about ten fold that of unexposed persons (Tandon *et al.*, 1977).

In almost all positions at a US chromate pigment plant, production workers were exposed to hexavalent chromium in the form of zinc and lead chromates. Concentrations of airborne chromium were estimated to be more than 2 mg/m^3 for highly exposed workers, between 0.5 and 2 mg/m^3 for moderately exposed workers and less than 0.1 mg/m^3 for the low-exposure category (Sheffett *et al.*, 1982).

(iii) *Leather tanning* (see also IARC, 1981)

The most common tanning process involves the use of basic chromic sulfate liquor. Tanning is accomplished in large vats where the hides are soaked with de-hairing, neutralizing, pickling, colouring and finishing chemicals. In the two-bath method, the hides are first immersed in a bath of hexavalent chromium salts (potassium or sodium dichromate), sodium chloride and sulfuric acid, and then removed and placed in a reduction bath to reduce the dichromate to trivalent chromic sulfate. An exothermic reaction takes place with a reduction agent such as sugar, starch or sulfur dioxide. The majority of tanneries do not produce their own tanning liquors, and a large number of proprietary products are available for direct use. Occupational exposure to chromium in the tanning industry may occur through contact with the trivalent chromium solutions. Wet, freshly tanned skins contain 1-2% chromium by weight, and dry leather powder contains 2-6% depending on the method and degree of tanning (Stern, 1982; Stern *et al.*, 1987).

Airborne levels of 20-50 $\mu\text{g}/\text{m}^3$ trivalent chromium were measured in 1975 in an Italian tannery when tanning baths were emptied (IARC, 1980a).

Air concentrations of trivalent chromium in a Finnish tannery were 1-29 $\mu\text{g}/\text{m}^3$ (personal samples). Two press operators were exposed to a mean level of 13 $\mu\text{g}/\text{m}^3$, and their urinary chromium excretion varied during one working week from 5 to 62

$\mu\text{g/l}$. A diurnal variation was evident, with the highest values occurring in post-shift samples. Blood samples contained 10-22 $\mu\text{g/l}$ chromium in the plasma and 4.7-11 $\mu\text{g/l}$ in whole blood; plasma levels were $< 1 \mu\text{g/l}$ in workers who were less exposed to tanning liquors. During press operations, splashes are common, and absorption from the gastrointestinal tract was suggested to be the main route of exposure (Aitio *et al.*, 1984).

Urine samples were collected from 34 male tannery workers in Turkey. The mean urinary concentration of chromium was 6.6 $\mu\text{g/l}$ (5.6 $\mu\text{g/g}$ creatinine) in tannery workers, 2.3 $\mu\text{g/l}$ (1.9 $\mu\text{g/g}$ creatinine) in office and kitchen workers at the same factory and 0.22 $\mu\text{g/l}$ (0.26 $\mu\text{g/g}$ creatinine) in unexposed controls (Saner *et al.*, 1984).

In two leather tanning facilities in the USA, the total concentration of chromium in work place air was 0.2-54 $\mu\text{g/m}^3$, with a mean of 39 $\mu\text{g/m}^3$ (Stern *et al.*, 1987).

(iv) *Chromium plating*

There are two types of chromium electroplating: decorative ('bright') and hard chromium plating. In decorative plating, a thin (0.5-1 μm) layer of chromium is deposited over nickel or nickel-type coatings to provide protective, durable, non-tarnishable surface finishes. Hard chromium plating produces a thicker (5-10 μm) coating, usually directly on the base metal, to increase its heat, wear and corrosion resistance. Plating baths contain chromium trioxide (250-350 g/l) and sulfuric acid (2.5-3.5 g/l) or a mixture of sulfuric acid and fluoride or fluorosilicate, as well as various organic additives. Electrolysis emits bubbles of oxygen and hydrogen that generate chromium trioxide mist by bursting at the liquid surface. Surfactants and floating balls may be used to control the mist emission (Guillemin & Berode, 1978; Stern, 1982; Sheehy *et al.*, 1984). Exposure to substances other than chromium occurs in a number of pretreatment and finishing operations: acid and alkali mists, nitrogen oxides, cyanide and solvents may be released during pickling, acid dipping, stripping and degreasing processes, and metal and abrasive dusts are released from grinding and polishing. In some plants, decorative-chrome platers also perform nickel plating (Sheehy *et al.*, 1984).

Air measurements made in metal plating plants since 1928 are summarized in Table 13. It is apparent that exposures to chromium have been markedly reduced with modern technology. In most studies, the levels were measured as total water-soluble chromium or hexavalent chromium and reported as a chromium trioxide concentration.

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Table 13. Workplace levels of hexavalent chromium during metal plating

Reference and country	Process and sampling data	Chromium oxide (chromium VI) concentration ($\mu\text{g}/\text{m}^3$)
Bloomfield & Blum (1928) USA	Chromium plating 6 plants, 19 samples	120-6900 [60-3800]
Riley & Goldman (1937) USA	Chromium plating with no local exhaust with low local exhaust with high local exhaust	2780-3680 [1440-1910] 11 200 [580] 340 [180]
Gresh (1944) USA	Chromium plating 7 samples	90-1200 [45-600]
Molos (1947) USA	Chromium plating with local exhaust with plastic beads on the bath with plastic beads and local exhaust	4500-5000 [2300-2500] 1900-3000 [950-1500] 20-50 [10-25]
Sheehy <i>et al.</i> (1984) USA	Chromium plating with no local exhaust with local exhaust with local exhaust and plastic beads on the bath	[140-2960] [0.5-270] [0.5-5]
Lumio (1953) Finland	Chromium plating 16 plants	< 3 [< 1.5]
Hama <i>et al.</i> (1954) USA	Decorative chromium plating 4 plants	2-60 [1-30]
Kleinfeld & Rosso (1965) USA	Decorative chromium plating with no local exhaust with local exhaust	180-1400 [90-730] 2-9 [2-5]
Hanslian <i>et al.</i> (1967) Czechoslovakia	Chromium plating 8 plants	23-681 [12-330]
Mitchell (1969) UK	Chromium plating (stripping) with no local exhaust with local exhaust	240-21 300 [120-10 600] 10-30 [5-15]
Gomes (1972) Brazil	Chromium plating 8 hard chromium plants 63 decorative chromium plants	< 100-1400 [< 50 -700] < 100-700 [< 50 -350]

Table 13 (contd)

Reference and country	Process and sampling data	Chromium oxide (chromium VI) concentration ($\mu\text{g}/\text{m}^3$)
National Institute for Occupational Safety and Health (1973-81) (reviewed by Sheehy <i>et al.</i> , 1984) USA	Hard chromium plating plant 1 plant 2 plant 3 plant 4 Decorative chromium plating plant 5 plant 6 plant 7 plant 8 Nickel-chromium plating plant 9 Zinc plating plant 10 plant 11	[1.1-48.6] [0.8-9.6] [3.6-66.0] [3-6] [< 0.5-3] [0.2-5.9] [0.2-9.0] [< 3] [2.9] [< 1.2-3.6] [0.3]
Royle (1975a) UK	Chromium plating 40 plants 2 plants	< 30 [< 15] > 30 [> 15]
Yunusova & Pavlovskaya (1975) [quoted by the World Health Organization, 1988] USSR	Chromium plating 8 plants	[40-400]
Michel-Briand & Simonin (1977) France	Chromium plating	5-15 [2.5-7.5]
Guillemin & Berode (1978) Switzerland	Hard chromium plating 6 plants, 23 samples Bright chromium plating 6 plants, 11 samples	2-655 [1-330] 2-26 [1-13]
Ekholm <i>et al.</i> (1983) Sweden	Hard chromium plating 4 plants Decorative chromium plating 9 plants	< 1-46 < 1-2
Mutti <i>et al.</i> (1984) Italy	Chromium plating 24 hard chromium platers 16 bright chromium platers	[4-146] [0-31]

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Table 13 (contd)

Reference and country	Process and sampling data	Chromium oxide (chromium VI) concentration ($\mu\text{g}/\text{m}^3$)
Sheehy <i>et al.</i> (1984) USA	Chromium, nickel, zinc, copper, cadmium and silver plating, 8 plants 53 personal samples 293 tank area samples 39 general area samples	[< 1-14] [< 1-11 000] [< 1-31]
Sorahan <i>et al.</i> (1987) UK	Decorative chromium plating 60 samples before 1973 numerous samples after 1973	0-8000 [0-4000] < 50 [< 25]

Typical levels of chromium in post-shift urine samples from electroplaters are given in Table 14. In one study of 21 electroplaters, chromium levels in serum were 0.2-1.3 $\mu\text{g}/\text{l}$ (Verschoor *et al.*, 1988). High concentrations of chromium were found in the respiratory organs of two chromium platers as well as in the spleen, liver, kidney and heart (Teraoka, 1987).

Table 14. Urinary concentrations of chromium in electroplaters

Reference and country	Type of workers (no.)	Mean and range of chromium concentrations in urine ($\mu\text{g}/\text{l}$ or $\mu\text{g}/\text{g}$ creatinine)
Franzen <i>et al.</i> (1970) Federal Republic of Germany	Chromium platers (133)	< 4-32 $\mu\text{g}/\text{l}$
Schaller <i>et al.</i> (1972) Federal Republic of Germany	Chromium platers (12)	9.7 (1.4-24.6) $\mu\text{g}/\text{l}$
Guillemin & Berode (1978) Switzerland	Hard chromium platers ^a (21) Bright chromium platers ^a (16)	23 $\mu\text{g}/\text{l}$ (18 $\mu\text{g}/\text{g}$) 5.6 $\mu\text{g}/\text{l}$ (5.3 $\mu\text{g}/\text{g}$)
Sarto <i>et al.</i> (1982) Italy	Bright chromium platers (17) Hard chromium platers (21)	6.1 $\mu\text{g}/\text{g}$ 10.0 $\mu\text{g}/\text{g}$
Lindberg & Vesterberg (1983) Sweden	Chromium platers (90)	[< 0.3-98 $\mu\text{g}/\text{l}$] Calculated by the Working Group from plots

Table 14 (contd)

Reference and country	Type of workers (no.)	Mean and range of chromium concentrations in urine ($\mu\text{g/l}$ or $\mu\text{g/g}$ creatinine)
Mutti <i>et al.</i> (1984) Italy	Hard chromium platers ^a (24)	15.3 $\mu\text{g/g}$
	Bright chromium platers ^a (16)	5.8 $\mu\text{g/g}$
Verschoor <i>et al.</i> (1988) Netherlands	Chromium platers (21)	9 (1-34) $\mu\text{g/g}$
Nagaya <i>et al.</i> (1989) Japan	Chromium platers (44)	0.25 (0.05-1.54 $\mu\text{mol/l}$) [13 (3-80) $\mu\text{g/l}$]

^aCorresponding air concentrations can be found in Table 13.

(v) *Welding*

Welding produces particulate fumes that have a chemical composition reflecting the elemental content of the consumable used. For each couple of process/material of application, there is a wide range of concentrations of the elements present in the fume. Chromium and nickel are found in significant concentrations in fumes from welding by manual metal arc, metal inert gas and tungsten inert gas processes on stainless and alloy steels. Typical ranges of total fume, total chromium and hexavalent chromium found in the breathing zone of welders are presented in Table 15. Certain special process applications not listed can also produce high chromium and nickel concentrations, and welding in confined spaces produces significantly higher concentrations of total fume and elemental constituents. Exposure to welding fumes that contain nickel and chromium can lead to elevated levels of these elements in tissues, blood and urine (see monograph on welding for details).

(vi) *Other occupations*

During the production of trivalent chromium compounds (chromic oxide and chromic sulfate) in the Federal Republic of Germany, work place air contained 180-13 200 $\mu\text{g/m}^3$ chromic oxide and 850-2700 $\mu\text{g/m}^3$ chromic sulfate during filtering, drying and unloading operations (Korallus *et al.*, 1974a).

Exposures of spray painters to solvents and paint mists have been measured in a variety of industries by the US National Institute for Occupational Safety and Health. Air concentrations of total chromium in breathing zone samples were 1600 $\mu\text{g/m}^3$ during aircraft painting, 220 $\mu\text{g/m}^3$ during railroad car painting and 5-9 $\mu\text{g/m}^3$ during metal furniture painting (O'Brien & Hurley, 1981). At a US plant manu-

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Table 15. Total fume and chromium concentrations found in the breathing zone of welders^a

Process ^b	Total fume ^c (mg/m ³)	Total Cr (µg/m ³)	Cr(VI) (µg/m ³)
MMA/SS	2-40	30-1600	25-1500 ^d
MIG/SS	2-3	60	< 1
TIG/SS	1-3	10-55	< 1

^aFrom van der Wal (1985)^bMMA, manual metal arc; SS, stainless steel; MIG, metal inert gas; TIG, tungsten inert gas^c50%-90% range^d50%-90% Cr(VI) from MMA/SS is soluble in water (Stern, 1982).

facturing truck bodies and refuse handling equipment, breathing zone concentrations of paint mists ranged from 4.8 to 47 mg/m³ total dust and 10 to 400 µg/m³ chromium (Vandervort & Cromer, 1975). Personal air samples had concentrations of hexavalent chromium ranging from 30 to 450 µg/m³ with a mean of 230 µg/m³ during spray painting of buses (Zey & Aw, 1984), 13 to 2900 µg/m³ with a mean of 607 µg/m³ during spray painting of aircraft wheels (Kominsky *et al.*, 1978) and 10 to 40 µg/m³ with a mean of 20 µg/m³ during spray painting of bridge girders (Rosensteel, 1974).

Breathing zone samples were also taken in a small automotive body repair workshop in the USA. One of the eight samples contained 490 µg/m³ chromium; the others were below the detection limit (Jayjock & Levin, 1984).

In a Swedish study, mean chromium levels of 1300 µg/m³ were measured during car painting and 500 µg/m³ during industrial painting, while work place levels averaged 300 µg/m³ during grinding activities (Elofsson *et al.*, 1980). Low overall levels were found for spray painters working in a fireplace manufacturing plant; the concentrations of total dust and chromium oxide [unspecified] were 1700 and 5-8 µg/m³ [chromium, 3-4 µg/m³], respectively (Hellquist *et al.*, 1983).

In Italy, 12 spray painters using lead and zinc chromate paints were exposed to levels of 450-1450 µg/m³ insoluble hexavalent chromium, and their mean urinary excretion was 13.2 µg/g creatinine at the end of a work shift (Mutti *et al.*, 1984).

At the largest wood treatment plant in Hawaii, air concentrations of 2-9 µg/m³ chromium were measured. Urinary excretion of 89 workers using chromated copper arsenate wood preservatives did not differ from that of controls (Takahashi *et al.*, 1983).

In a cement-producing factory in the USSR, concentrations of hexavalent chromium in work place air varied from 5 to 8 $\mu\text{g}/\text{m}^3$, measured as chromium trioxide (Retnev, 1960). Hexavalent chromium was found in 18 of 42 US cement samples at concentrations ranging from 0.1 to 5.4 $\mu\text{g}/\text{g}$, with a total chromium content of 5-124 $\mu\text{g}/\text{g}$ (Perone *et al.*, 1974). Portland cement contains 41.2 ppm (mg/kg) chromium (range, 27.5-60), due to the presence of chromium in limestone. Soluble chromium in cement averaged 4.1 mg/kg (range, 1.6-8.8), of which 2.9 mg/kg (range, 0.03-7.8) was hexavalent chromium (Fishbein, 1976). Analysis of 59 samples of Portland cement from nine European countries showed concentrations of 1-83 $\mu\text{g}/\text{g}$ hexavalent chromium and 35-173 $\mu\text{g}/\text{g}$ total chromium (Fregert & Gruvberger, 1972). In France and Belgium, cements manufactured in 11 plants contained 8-49 $\mu\text{g}/\text{g}$ total chromium, originating from limestone, clay, gypsum, fly ash and slag used in the manufacture as well as from the refractory kiln materials (Haguenoer *et al.*, 1982). Cement in Iceland contained 5.8-9.5 mg/kg hexavalent chromium (Rafnsson & Jóhannesdóttir, 1986).

In open-cast chromium mining in the USSR, concentrations of total airborne dust ranged from 1.3 to 16.9 mg/m³; in the crushing and sorting plant, dust levels were 6.1-188 mg/m³. The chromium content of settled dust varied from 3.6 to 48% (calculated as chromic oxide). No hexavalent chromium was found in the dust (Pokrovskaya *et al.*, 1976; World Health Organization, 1988).

During the manufacture of chromium[III] lignosulfonate in Finland, five packing workers were exposed to dust containing about 2% trivalent chromium. The product contained 6% trivalent chromium attached to wood lignin. In personal samples, the concentration of chromium in the air was 2-230 $\mu\text{g}/\text{m}^3$, and three-day averages ranged from 11 to 80 $\mu\text{g}/\text{m}^3$. Urinary levels in samples from workers were 0.01-0.59 $\mu\text{mol}/\text{l}$ (0.5-30 $\mu\text{g}/\text{l}$), and mean excretion was 0.02-0.23 $\mu\text{mol}/\text{l}$ (1-12 $\mu\text{g}/\text{l}$). It was concluded that chromium occurred exclusively in a trivalent state in both dust and urine (Kiilunen *et al.*, 1983).

(c) Air

Chromium is generally associated with particulates in ambient air at concentrations of 0.001-0.1 $\mu\text{g}/\text{m}^3$ (Fishbein, 1976; O'Neill *et al.*, 1986). In the USA in 1966, only seven of 58 cities in the National Air Sampling Network had annual average chromium levels of 0.01 $\mu\text{g}/\text{m}^3$ or more, and only 16 had maximal single values above that level. In approximately 200 urban stations in the USA during 1960-69, annual mean concentrations were 0.01-0.03 $\mu\text{g}/\text{m}^3$ (minimal level detectable, 0.01 $\mu\text{g}/\text{m}^3$). In nonurban areas, the level of chromium was less than 0.01 $\mu\text{g}/\text{m}^3$. Levels of 0.9-21.5 $\mu\text{g}/\text{m}^3$ were reported in 23 localities in northern England and Wales in 1956-58 (Fishbein, 1976). In 1957-74, the amount of chromium in the atmospheric

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aerosol at a rural site in the UK declined at an average yearly rate of 11.3% (Salmon *et al.*, 1977).

During the period May 1972-April 1975, the range of average levels of chromium determined at 15 stations in Belgium was 0.01-0.04 $\mu\text{g}/\text{m}^3$ (maximal value, 0.54 $\mu\text{g}/\text{m}^3$). The values were stated to reflect background pollution and levels representative of those in air inhaled by the majority of the population. Sampling station locations were selected to avoid, as much as possible, a direct influence of local sources (Kretzschmar *et al.*, 1977).

Coal from many sources can contain as much chromium as soils and rocks, i.e., up to 54 ppm (mg/kg); consequently, the burning of coal can contribute to chromium levels in air, particularly in cities (Fishbein, 1976; Merian, 1984). Particulates emitted from coal-fired power plants contained 2.3-31 ppm (mg/kg) chromium, depending on the type of boiler firing; the emitted gases contained 0.22-2.2 mg/ m^3 . These concentrations were reduced by fly ash collection to 0.19-6.6 ppm (mg/kg) and 0.018-0.5 mg/ m^3 , respectively (Fishbein, 1976). Fly ash has been shown to contain 1.4-6.1 ppm (mg/kg) chromium[VI] (Stern *et al.*, 1984).

Mean concentrations in the air of US cities with metallurgical chromium or chromium chemical producers or with refractories were 0.012-0.016 $\mu\text{g}/\text{m}^3$, all of which were higher than the US national average. Cement-producing plants are probably an additional source of chromium in the air. When chromate chemicals are used as rust inhibitors in cooling towers, they are dissolved in recirculating water systems, which continually discharge about 1% of their flow to waste. Additionally, chromate and water are lost to the atmosphere (Fishbein, 1976).

The concentration of chromium in the air at the South Pole was reported to be 0.005 ng/ m^3 . Concentrations in samples taken over the Atlantic Ocean ranged from 0.007 to 1.1 ng/ m^3 . Airborne chromium concentrations were reported to be 0.7 ng/ m^3 in the Shetland Islands and Norway, 0.6 in northwestern Canada, 1-140 in Europe, 1-300 in North America, 20-70 in Japan and 45-67 in Hawaii, USA (Cary, 1982).

(d) *Water*

Naturally occurring chromium concentrations in water arise from mineral weathering processes, soluble organic chromium, sediment load and precipitation (Cary, 1982).

Concentrations of chromium in rivers have been found to be 1-10 $\mu\text{g}/\text{l}$. Chromium (both hexavalent and trivalent) is generally found at lower concentrations in seawater (well below 1 $\mu\text{g}/\text{l}$) than in rivers and wells. It has been estimated that 6.7 million kg of chromium are added to the oceans every year. As a result, much of the chromium lost from the land by erosion and mining is eventually deposited on the ocean floor (Fishbein, 1976).

The mean chromium concentration in ocean water in 1979 was 0.3 µg/l, with a range of 0.2-50 µg/l. Samples taken from the first 100 m of water from several areas of the Pacific Ocean contained about 0.12 µg/l chromium, about 83% being hexavalent chromium; below 100 m, total chromium increased to about 0.16 µg/l, with hexavalent chromium accounting for 90%. In saline waters of Australia, 62-87% of the labile chromium present (< 1 µg/l) was hexavalent (Cary, 1982).

Of 1500 samples of US surface waters taken between 1960 and about 1968, 24.5% contained chromium detectable spectrographically; the maximal and mean levels observed were 112 and 9.7 µg/l, respectively (Kroner, 1973). A survey of chromium content of 15 North American rivers showed levels of 0.7-84 µg/l, with most in the range of 1-10 µg/l (Hartford, 1979). Levels in 3834 samples of tap water taken from 35 regions of the USA in 1974-75 ranged from 0.4 to 8 µg/l chromium, with the median 1.8 µg/l (US Environmental Protection Agency, 1984).

Of 170 samples taken from lakes in the higher Sierra Mountains of California, USA, in 1968, only two contained as much as 5 µg/l chromium. Chromium concentrations in 1977 in the Amazon (Brazil) and Yukon (USA) Rivers were 2.0 and 2.3 ppb (µg/l), respectively; the two rivers were considered to represent unpolluted systems draining watersheds of a wide variety of mineral types from extremely different climates. The concentration of chromium in 96% of the 4342 samples of stream- and river-water in Canada was less than 10 µg/l; about 2% of the samples contained 15-500 µg/l chromium (Cary, 1982).

The mean concentration of dissolved chromium compounds in the Rhine River during 1975 was 6.5 µg/l with a range of 3.7-11.4 µg/l; the concentration in drinking-water was 0.29 µg/l (Nissing, 1975). The concentration of chromium compounds in Austrian medicinal and table waters was determined as 1.2-4.2 µg/l (Sontag *et al.*, 1977). The average levels of chromium in three tributaries of the Han River in the Republic of Korea were found to be 96, 106 and 65 µg/l (Min, 1976).

Municipal sewage sludge can contain chromium at levels up to 30 000 mg per kg dry sludge (Pacyna & Nriagu, 1988).

Surface waters and groundwaters contaminated with wastewaters from electroplating operations, leather tanning and textile manufacturing, or through deposition of airborne chromium, may also be sources of chromium exposure. Other sources are solid wastes resulting from the roasting and leaching steps of chromate manufacture and improper disposal of municipal incineration wastes in landfill sites (Beszedits, 1988; Calder, 1988; Handa, 1988).

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(e) *Soil and plants*

Chromium is present in the soil at levels which vary from traces to 250 mg/kg (as chromic[III] oxide) (Davis, 1956) and is particularly prevalent in soil derived from basalt or serpentine (US Environmental Protection Agency, 1984).

Virtually all plants contain detectable levels of chromium, taken up by the roots or through the leaves. Vegetables from 25 botanical families were found to contain chromium in amounts varying from 10-1000 µg/kg of dry matter, with most samples in the range of 100-500 µg/kg (Davis, 1956). Strong seasonal variations in chromium levels were found in three kinds of grass (World Health Organization, 1988).

The chromium content of mosses and liverworts collected in 1951 in a remote rural area in Denmark was compared with that in the same plants collected in 1975: an increase of about 62% was observed, which coincided with increases in industrial activity and fossil fuel combustion (Rasmussen, 1977).

The chromium content of cigarette tobacco from different sources has been reported as follows: Iraq, 8.6-14.6 mg/kg (two varieties); Iran, 4.3-6.2 mg/kg (two brands); and the USA, 0.24-6.3 mg/kg (Al Badri *et al.*, 1977).

(f) *Food*

The chromium content of most foods is extremely low; small amounts were found in vegetables (20-50 µg/kg), fruits (20 µg/kg) and grains and cereals (excluding fats, 40 µg/kg). The mean daily intakes of chromium from food, water and air have been estimated to be 280, 4 and 0.28 µg, respectively (Fishbein, 1976). Hartford (1979) indicated that nearly all foodstuffs contain chromium in the range of 20-590 µg/kg, resulting in a daily intake for humans of 10-400 µg, with an average of about 80 µg. In a more recent study, the mean daily intake of chromium for 22 healthy subjects was about 24.5 µg (Bunker *et al.*, 1984).

(g) *Animal tissues*

Table 16 summarizes data on chromium levels in tissues from various food and feral animals.

The report of the US National Status and Trends Program for Marine Environmental Quality, conducted by the National Oceanic and Atmospheric Administration (1987), gave concentrations of chromium at 0.1-11.0 µg/g (dry weight) in mussels and oysters collected in 1986 at East, West, and Gulf Coast sites, and 0.02-1.4 µg/g (dry weight) in livers of ten species of fish collected in 1984 throughout the USA.

Table 16. Chromium levels found in food and feral animals

Animal	Tissue	Range (mean) (µg/kg)	Comments	Reference
Largemouth bass	Muscle	1-2	Collected near Savannah River, SC, USA, nuclear plant	Koli & Whitmore (1983)
Bluegill		1		
Catfish		1		
Redbreast sunfish		1		
Crappie, American eel		2		
Spotted sunfish		1-2		
American shad	Gonad	ND-180	Collected in 1979, USA	Eisenberg & Topping (1986)
	Flesh	ND		
Finfish	Flesh	ND-1900	Collected in 1978-79	
Striped bass	Gonad	ND	Collected in 1978-79	
	Liver	ND	Collected in 1978-79	
	Flesh	ND	Collected in 1978-79	
Striped bass	Liver	2600-9800 (6000)	Collected from Chesapeake Bay, MD, USA	Heit (1979)
	Muscle	2700-9500 (5000)		
Cattle	Blood	(25/10)	Grazed on pasture treated/untreated with sludge (from Chicago, IL, USA)	Fitzgerald <i>et al.</i> (1985)
	Bone	(614/934)		
	Brain	(209/306)		
	Diaphragm	(206/215)		
	Heart	(172/434)		
	Kidney	(231/390)		
	Liver	(186/365)		
	Milk	(248/160)		
Cattle	Liver	200-3000		Stowe <i>et al.</i> (1985)
Cattle	Kidney	< 10-30	Collected from slaughter-houses in Queensland, Australia	Kramer <i>et al.</i> (1983)
	Liver	< 10-910 (10)		
	Muscle	< 10-100		
Cattle	Blood	6-66 (22) 1080	Oklahoma, USA Unexposed animals Animal found dead near an oil-well drilling site	Kerr & Edwards (1981)
	Kidney	500-6200 (2970) 15 800	Unexposed animals Animal found dead near a recently completed oil well	

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Table 16 (contd)

Animal	Tissue	Range (mean) (µg/kg)	Comments	Reference
Clam American oyster	Body	(2100-3800) (1300)	Collected from Lake Pontchartrain, LA, USA	Byrne & DeLeon (1986)
Pike-perch	Body	10-20 (10)	The Netherlands	Vos <i>et al.</i> (1986)
Cod		10-20 (10)	Hollands Diep	
Baltic herring		10-70 (20)	Collected near the coast	
Sole		10-20 (20)		
Eel		20-340 (80)	Collected from Lake Ijssel	
Pike-perch		10-70 (20)	Collected from Eastern Scheldt	
Blue mussel		210-810 (430)	Collected from Western Wadden Sea	
Shrimp		100-710 (260)		
Killifish	Body	(3600-7600)	Collected near electroplating industry, RI, USA	Custer <i>et al.</i> (1986)
Common tern	Liver	ND-18 310		
Cape oyster	Body	< 100-4600	Collected along the coast of South Africa	Watling & Watling (1982)
Sponge	Body	1 000 000-2 000 000 (1 520 000)	Collected near the Tarapur coast, India	Patel <i>et al.</i> (1985)
Snapping turtle	Kidney	(930-1260)	Collected from uncontaminated areas of MD, USA	Albers <i>et al.</i> (1986)
	Liver	(100-1970)		
	Kidney	(1130-2970)	Collected from contaminated areas of NJ, USA	
	Liver	(360-600)		
Crab	Body	40-200 (120)	Collected in sewage outfall area of the Arabian Gulf, Saudi Arabia	Sadiq <i>et al.</i> (1982)
Shrimp		29-133 (59)		
Pacific oyster	Body	(93 000, 113 000)	Collected from two culture beds in Deep Bay, Hong Kong	Wong <i>et al.</i> (1981)
	Gills	(40 000, 170 000)		
	Intestine	(42 000, 106 000)		
	Mantle	(47 000, 188 000)		
	Muscle	(35 000, 111 000)		

ND, none detected

(h) *Human tissues and secretions*

As with most metals that occur in trace quantities, the normal concentrations of chromium in human tissues are usually reported wrongly because of extraneous additions during sampling and analysis. However, recent developments in the analytical chemistry of chromium permit the reliable routine determination of nanogram quantities in biological samples (Nieboer & Jusys, 1988). Selected current reference values for chromium concentrations in a few biological materials are presented in Table 17.

Table 17. Chromium concentrations in specimens from non-occupationally exposed persons^a

Sample	Median	Range
Serum	0.19 µg/l	0.12-2.1 µg/l
Blood	< 0.5 µg/l	-
Urine	0.4 µg/l	0.24-1.8 µg/l
Liver	^c	8-72 ng/g wet weight
Lung ^b	204 ng/g wet weight	29-898 ng/g wet weight

^aFrom Iyengar & Woittiez (1988), except when noted

^bFrom Raithel *et al.* (1987)

^cToo few measurements to determine median values

(i) *Regulatory status and guidelines*

The 1970 WHO European and 1978 Japanese standard for chromium[VI] in drinking-water (World Health Organization, 1970; Ministry of Health & Welfare, 1978) and the European standard for total chromium in surface water intended for the abstraction of drinking-water (Commission of the European Communities, 1975) are 0.05 mg/l. The US Environmental Protection Agency (1988) has established the same maximal contaminant level for chromium in drinking-water, as the maximal permissible level in water delivered to any user of a public water system.

The US Environmental Protection Agency (1979) also established pretreatment standards that limit the concentration of chromium that may be introduced into a publicly owned wastewater treatment facility by leather tanning and finishing plants. The maximal total chromium permitted in existing sources on any one day is 6 mg/l, and the average daily values for 30 consecutive days must not exceed 3 mg/l.

Table 18 gives occupational exposure limits for airborne chromium in various forms.

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Table 18. Occupational exposure limits for airborne chromium in various forms^a

Country or region	Year	Form of chromium	Concentration (mg/m ³)	Interpretation ^b
Austria	1987	Cr, soluble compounds (as Cr)	0.1	TWA
Belgium	1987	Cr, compounds (as Cr)	0.05	TWA
		Cr, soluble compounds (as Cr)	0.1	TWA
Brazil	1987	Cr, compounds (as Cr)	0.04	TWA
Bulgaria	1987	Cr, compounds (as Cr)	0.1	TWA
Chile	1987	Cr, compounds (as Cr)	0.04	TWA
China	1987	Cr, compounds (as CrO ₃), chromium trioxide, chromates, dichromates (as CrO ₃)	0.5	TWA
Czechoslovakia	1987	Cr, compounds (as Cr)	0.05	Average
		Cr, compounds (as Cr)	0.1	Maximum
Denmark	1988	Cr and inorganic Cr compounds, except those mentioned below	0.5	TWA
		Chromates, chromium trioxide (as Cr)	0.02	TWA
Egypt	1987	Cr, compounds (as Cr)	0.1	TWA
Finland	1987	Cr, Cr[II] and Cr[III] compounds (as Cr)	0.5	TWA
		Cr[VI] compounds (as Cr)	0.05	TWA
France	1986	Cr[VI] and derivatives	0.05	TWA
German Democratic Republic	1987	Cr, compounds, except those mentioned below	0.5	TWA
		Chromium trioxide, chromates, dichromates (as CrO ₃)	1.0	STEL
			0.1	TWA
			0.1	STEL
Hungary	1987	Cr, compounds (as Cr)	0.05	TWA
			0.1	STEL
India	1987	Cr, compounds (as Cr)	0.05	TWA
		Cr, soluble compounds (as Cr)	0.5	TWA
Indonesia	1987	Cr, compounds (as Cr)	0.1	TWA
Italy	1987	Cr, compounds (as Cr)	0.05	TWA
		Cr, soluble compounds (as Cr)	0.5	TWA
Japan	1987	Cr, compounds (as Cr)	0.1	TWA
Korea, Republic of	1987	Cr, compounds (as Cr)	0.05	TWA
Mexico	1987	Chromite ore (as Cr)	0.05	TWA
		Cr, compounds (as Cr); insoluble, soluble Cr[II], Cr[III], Cr[VI] compounds (as Cr)	0.5	TWA

Table 18 (contd)

Country or region	Year	Form of chromium	Concentration (mg/m ³)	Interpretation ^b
Netherlands	1986	Cr, soluble compounds (as Cr)	0.5	TWA
		Chromyl chloride	0.15	TWA
		Cr, insoluble compounds; chromium trioxide (as Cr)	0.05	TWA
Norway	1981	Cr, Cr[II] and Cr[III] compounds (as Cr)	0.5	TWA
		Chromates, chromium trioxide (as Cr)	0.02	TWA
Sweden	1987	Cr and inorganic Cr compounds, except those mentioned below	0.5	TWA
		Chromates, chromium trioxide (as Cr)	0.02	TWA
Switzerland	1987	Cr, compounds (as Cr); Cr, soluble compounds (as Cr)	0.5	TWA
		Cr[II] and Cr[III] soluble compounds; chromium oxychloride dust (as Cr)	0.05	TWA
Taiwan	1987	Cr and compounds (as Cr)	0.1	TWA
UK	1987	Cr, Cr[II] and Cr[III] compounds (as Cr)	0.5	TWA
		Cr[VI] compounds (as Cr)	0.05	TWA
USA ^c				
ACGIH	1988	Zinc chromates (as Cr)	0.01	TWA
		Chromite ore (chromate) (as Cr); water-soluble and certain (confirmed human carcinogens) water-insoluble Cr[VI] compounds (as Cr); lead chromate (as Cr)	0.05	TWA
		Chromium metal, Cr[II] and Cr[III] compounds (as Cr)	0.5	TWA
NIOSH	1988	Carcinogenic Cr[VI]	0.001	TWA
		Other Cr[VI]; chromic acid	0.025	TWA
		(as noncarcinogenic Cr[VI])	0.05	Ceiling (15 min)
OSHA	1987	Soluble chromium, chromic and chromous salts	0.5	TWA
		Chromium metal and insoluble salts	1.0	TWA
USSR	1987	Cr and compounds (as Cr)	0.01	MAC
		Chromium phosphate uni-substituted (as Cr[III])	0.02	MAC

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Table 18 (contd)

Country or region	Year	Form of chromium	Concentration (mg/m ³)	Interpretation ^b
Yugoslavia	1987	Cr and compounds (as Cr)	0.1	TWA

^aFrom Arbeidsinspectie (1986); Institut National de Recherche et de Sécurité (1986); Arbetarskyddsstyrelsens (1987); Cook (1987); Health and Safety Executive (1987); US Occupational Safety and Health Administration (1987); Työsuojeluhallitus (1987); American Conference of Governmental Industrial Hygienists (1988); Arbejdstilsynet (1988); National Institute for Occupational Safety and Health (1988)

^bTWA, time-weighted average; STEL, short-term exposure limit; MAC, maximum allowable concentration

^cACGIH, American Conference of Governmental Industrial Hygienists; NIOSH, National Institute for Occupational Safety and Health; OSHA, Occupational Safety and Health Administration

2.4 Analysis

Numerous analytical methods have been developed for the qualitative and quantitative determination of chromium in a wide variety of matrices. Methods for analysing urban, industrial and work-place air, fresh water, sea-water, sewage effluents, sediments, soil, foodstuffs, crops, plants and biological materials such as human milk, blood, serum, urine and faeces and human and animal tissues, have been reviewed (National Research Council, 1974; Whitney & Risby, 1975; US Environmental Protection Agency, 1977, 1978; Slavin, 1981; Torgriksen, 1982; Love, 1983; Nieboer *et al.*, 1984; US Environmental Protection Agency, 1984; O'Neill *et al.*, 1986; Harzdorf, 1987; Cornelis, 1988; World Health Organization, 1988).

Typical methods for the analysis of chromium are summarized in Table 19.

Most instrumental procedures are not specific for the oxidation states of chromium and are suitable for total chromium determinations only, unless accompanied by prior separations or supportive qualitative analyses. The reagent *sym*-diphenylcarbazide forms a violet complex with chromium[VI] but not with other chromium compounds, and the stability of the colour contributes to the high sensitivity of the analysis of soluble chromate in aerosols, water, cement and other materials. Interfering, reducing or oxidizing substances, if present in the sample, must be taken into account, since they tend to cause erroneous results during sampling, sample storage and preparation and spectrometric measurement (National Institute for Occupational Safety and Health, 1975). The chromium content of single particles can be determined by electron microscopy combined with X-ray microanalysis. Electron spectroscopy can be used to measure the valency state of chromium in thin surface layers of solid samples (Lautner *et al.*, 1978).

Table 19. Analytical methods for chromium and chromium compounds

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Formulations				
Tanning liquors (trivalent chromium)	Oxidize to Cr[VI] (dichromate) with ammonium persulfate (oxidant) and cupric sulfate-cobaltous nitrate mixture (catalyst)	IT	NR	Makarov-Zemlyanskii <i>et al.</i> (1978)
Pigments	Dissolve in hydrofluoric acid	EAAS	0.1 mg/kg	Kolihova <i>et al.</i> (1978)
Air				
Total chromium	Collect particulate sample on polystyrene filter; irradiate for 5 min at a flux of 2×10^{12} neutrons/cm ² × sec; count with a Ge(Li) detector	NAA	0.02 µg	Dams <i>et al.</i> (1970)
Total chromium	Extract collection filter with mixture of hot hydrochloric and nitric acids; concentrate extraction liquid; hold overnight; dilute	AAS	NR	Smith <i>et al.</i> (1976)
Total chromium	Collect particulate sample on acetate fibre superfilter; use filter as thin target sample and bombard in a proton beam for 10 min	X-REA	0.01 µg	Li <i>et al.</i> (1979)
Total chromium	Collect particulate sample on 0.8 µm cellulose ester membrane; extract with hydrochloric and nitric acids; dilute	AAS	0.06 µg	National Institute for Occupational Safety and Health (1984a); Eller (1984) [Method 7024]
Total chromium	Extract collection filter with mixture of concentrated nitric and perchloric acids; evaporate to dryness; redissolve in dilute nitric/perchloric acid mixture	ICP/AES	1 µg	Eller (1984) [Method 7300]; O'Neill <i>et al.</i> (1986)

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Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Total chromium	Collect particulate sample on cellulose nitrate membrane; extract with nitric acid; dilute	EAAS	0.09 µg	Kettrup <i>et al.</i> (1985)
Hexavalent chromium	Extract collection filter with 0.5 N sulfuric acid; filter to remove suspended dust; add <i>sym</i> -diphenylcarbazide	VIS	0.05 µg	Eller (1984) [Method 7600]; O'Neill <i>et al.</i> (1986)
Hexavalent chromium	Extract collection filter with hot 2% sodium hydroxide/3% sodium carbonate solution; add 6 N sulfuric acid and <i>sym</i> -diphenylcarbazide	VIS	0.05 µg	Eller (1984) [Method 7600]; O'Neill <i>et al.</i> (1986)
Hexavalent chromium	Collect particulate sample on 5.0-µm polyvinylchloride membrane; extract with sulfuric acid or with sodium hydroxide-sodium carbonate solution; add <i>sym</i> -diphenylcarbazide; measure absorption at 540 nm	VIS	0.05 µg	Abell & Carlberg (1974); Carelli <i>et al.</i> (1981); Bhargava <i>et al.</i> (1983); National Institute for Occupational Safety and Health (1984b)
Soluble chromium compounds	Collect aerosol sample compounds in sodium hydroxide solution with a midget impinger; oxidize Cr[III] compounds with bromine; add <i>sym</i> -diphenylcarbazide; measure absorption at 540 nm	VIS	2.3 µg/m ³	Kettrup <i>et al.</i> (1985)
Chromic acid	Collect aerosol sample on a cellulose ester membrane; chelate Cr[VI] with ammonium pyrrolidine dithiocarbamate; extract with methyl isobutyl ketone	EAAS	0.2 µg	National Institute for Occupational Safety and Health (1973)

Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Water				
Wastewaters	–	PP		Heigl (1978)
Total chromium			0.04 mg/l	
Hexavalent chromium			0.01 mg/l	
River water	Separate suspended particles by centrifugation; add diethyldithiocarbamate; filter through acetate superfilter; use filter as thin target sample and bombard in a proton beam for 10 min	X-REA	NR	Li <i>et al.</i> (1979)
Seawater	Extract with ammonium pyrrolidine dithiocarbamate into chloroform at pH 2	IDMS	0.001 µg/l	Osaki <i>et al.</i> (1976)
Hexavalent and total chromium				
Hexavalent and trivalent chromium, selective	Extract hexavalent chromium with Aliquat-336 (a mixture of methyl tri- <i>n</i> -alkyl ammonium chlorides) at pH 2; extract trivalent chromium by adding thiocyanate to at least 1M; adjust pH to 6-8	EAAS	0.01 µg/l [VI] 0.03 µg/l [III]	de Jong & Brinkman (1978)
Drinking-water, surface water, groundwater, domestic and industrial wastewaters	Various acidification/evaporation/dilution steps, depending on specific matrix and method	AAS	0.05 mg/l	US Environmental Protection Agency (1983, 1986) [Methods 218.1, 218.3, 3005, 3010, 7190]
Total chromium		ICP/AES	7 µg/l	[Methods 200.7, 6010]
		EAAS	1 µg/l	[Methods 218.2, 3020, 7191]
Hexavalent chromium	Acidify to pH 3.5 with acetic acid; add lead nitrate, glacial acetic acid and ammonium sulfate; centrifuge and discard supernatant; dissolve precipitate in concentrated nitric acid	EAAS	2 µg/l	US Environmental Protection Agency (1983, 1986) [Methods 218.5, 7195]

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Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Hexavalent chromium	Chelate with ammonium pyrrolidine dithiocarbamate or pyrrolidine dithiocarbamic acid in chloroform; extract with methyl isobutyl ketone	AAS	NR	US Environmental Protection Agency (1983, 1986) [Methods 218.4, 7197]
Hexavalent chromium	Use ammonium hydroxide/ammonium chloride as supporting electrolyte	DPP	10 µg/l	US Environmental Protection Agency (1986) [Method 7198]
Hexavalent chromium	Remove interfering metals by adding aluminium sulfate; filter; add sodium hypochlorite solution; add phosphoric acid solution and sodium chloride; add <i>sym</i> -diphenylcarbazide	VIS	NR	Deutsches Institut für Normung (1987) [DIN 38405]; (see also US Environmental Protection Agency (1986) [Method 7196])
Oily waste samples: oils, greases, waxes, crude oil (soluble chromium)	Dissolve in xylene or methyl isobutyl ketone	AAS	0.05 mg/l	US Environmental Protection Agency (1986) [Methods 3040, 7190]
Sediments, sludges, soils and solid wastes (total chromium)	Digest with nitric acid and hydrogen peroxide; dilute with dilute hydrochloric or nitric acid	ICP	7 µg/l	[Method 6010]
		AAS	0.05 mg/l	US Environmental Protection Agency (1986) [Methods 3050, 7190]
		ICP EAAS	7 µg/l 1 µg/l	[Method 6010] [Methods 3050, 7191]
Sediments	Activate with neutrons for 6 h	NAA	1.5 mg/kg	Ackermann (1977)
Food				
Tinned foods	Oxidize to hexavalent chromium with hydrogen peroxide; treat with <i>sym</i> -diphenylcarbazide	VIS	0.05 mg/kg	Il'inykh (1977)

Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Biological samples				
SRM 1569 brewers' yeast; SRM 1577 bovine liver; SRM 1570 spinach; human hair and nails	Chemical procedures developed for digestion of biological matrices and separation of chromium without large analytical blanks or significant losses by volatilization	IDMS	1 µg	Dunstan & Garner (1977)
Blood, plasma, urine	Dilute with Triton X100 solution; standard addition method	EAAS	NR	Morris <i>et al.</i> (1989)
Tissue	Digest sample with nitric and sulfuric acids with a defined time-temperature programme; dilute with water; standard addition method	EAAS	0.3 µg/g wet wt	Raithel <i>et al.</i> (1987)
Serum	–	NAA	NR	Versieck <i>et al.</i> (1978)
Serum, human milk, urine	Dilute with water	EAAS	0.05 ng/ml (urine, serum) 0.1 ng/ml (milk)	Kumpulainen <i>et al.</i> (1983)
Blood or tissue	Digest with mixture of nitric, perchloric and sulfuric acids; heat for 4-5 h; cool; dilute with deionized water or add yttrium internal standard	ICP/AES	0.01 µg/g blood 0.2 µg/g tissue	Eller (1985) [Method 8005]
Blood erythrocytes	Wash with isotonic saline; dilute with Triton X100 solution	EAAS	1 µg/l	Lewalter <i>et al.</i> (1985)
Human urine Total chromium	Adjust pH to 2.0 with sodium hydroxide; add polydithiocarbamate resin; filter, saving filtrate and resin; adjust filtrate to pH 8.0 and add more resin; ash filters and resins; add nitric/perchloric acid mixture and warm	ICP/AES	0.1 µg	Eller (1984) [Method 8310]

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Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Total chromium	Dilute and acidify with nitric acid	EAAS	0.1-0.5 µg/l	Nise & Vesterberg (1979); Kiilunen <i>et al.</i> (1987); Angerer & Schaller (1988)
Plant materials	Dry in an oven at 120°C for 2-4 h; ash in a muffle furnace at 550°C for 6 h	ES	2 mg/kg	Dixit <i>et al.</i> (1976)
Airborne chromium				
Welding fumes Hexavalent chromium	Extract with sodium carbonate; remove precipitate by filtration; add <i>sym</i> -diphenylcarbazide; measure absorption at 540 nm	EAAS	0.8 µg	Thomsen & Stern (1979)
Total and hexavalent chromium	Extract with sodium hydroxide and carbonate or fuse with sodium carbonate; remove precipitate by filtration; acidify with sulfuric acid; add <i>sym</i> -diphenylcarbazide; measure absorption at 540 nm	VIS	1 µg/m³	Moreton <i>et al.</i> (1983)
Hexavalent and trivalent chromium	Collect on polycarbonate membranes	ESCA, NAA	0.001 µg	Lautner <i>et al.</i> (1978)
Total, hexavalent and trivalent chromium	Collect on cellulose ester membranes	PIXE, ESCA, TEM, EDXA	0.0001-0.01 µg	Bohgard <i>et al.</i> (1979)
Welding fumes; complex matrices with redox systems				
Insoluble and total hexavalent chromium	Add sodium carbonate; warm; remove precipitate by filtration	AAS	1 µg/m³	Thomsen & Stern (1979)
Total chromium	Add phosphoric acid:sulfuric acid (3:1)	AAS	1 µg/m³	Pedersen <i>et al.</i> (1987)
Welding and brazing fumes	Sample on cellulose ester membrane filter; load sample and irradiate	XRF	2 µg	Eller (1984) [Method 7200]

Table 19 (contd)

Sample matrix	Sample preparation	Assay procedure ^a	Limit of detection ^b	Reference
Cement (hexavalent chromium)	Extract with water; add ammonium acetate and ethylene diamine	DPP	0.3 µg/g	Vandenbalck & Patriarche (1987)
Grinding dusts	Collect particulate sample on polycarbonate membrane	SEM, EDXA	NR	Koponen (1985)
Paint aerosols (hexavalent chromium)	Extract with a sodium hydroxide—sodium carbonate solution; dilute with buffer solution	IC	0.003 µg	Molina & Abell (1987)

^aAbbreviations: IT, iodometric titration; EAAS, electrothermal atomic absorption spectrometry; NAA, neutron activation analysis; AAS, atomic adsorption spectrometry; X-REA, X-ray emission analysis; ICP/AES, inductively coupled argon/plasma/atomic emission spectroscopy; VIS, visible absorption spectrometry; PP, pulse polarography; IDMS, isotope dilution mass spectrometry; DPP, differential pulse polarography; ES, emission spectrography; ESCA, electron spectroscopy for chemical analysis; PIXE, proton induced X-ray emission; TEM, transmission electron microscopy; EDXA, energy dispersive X-ray analysis; XRF, X-ray fluorescence; SEM, scanning electron microscopy; IC, ion chromatography

^bNR, not reported

The American Society for Testing and Materials (ASTM) has established standard methods for determining the chromium (or chromium compound) content of various commercial products. These include methods for the chemical analysis of chromium-containing refractory materials and chromium ore (ASTM C572-81), for chromium in water (ASTM D1687-86), for strontium chromate pigment (ASTM D1845-86) and for chromic oxide in leather that has been partly or completely tanned with chromium compounds (ASTM D2807-78); a colorimetric method for the determination of soluble chromium (trivalent and hexavalent chromium) in workplace atmospheres (ASTM D3586-85); methods for the determination of chromium (including chromium oxide) in the solids of liquid coatings (paint) or in dried films obtained from previously coated substrates (ASTM D3718-85a), for chromium in residues obtained by air sampling of dusts of lead chromate and lead silicochromate-type pigments (ASTM D4358-84), for chromium and ferrochromium (ASTM E363-83), for chromium oxide in chromium ores (ASTM E342-71), for yellow, orange and green pigments containing lead chromate and chromium oxide green (ASTM D126-87) and for zinc yellow pigment (zinc chromate yellow) (ASTM D444-88) (American Society for Testing and Materials, 1971, 1978, 1981, 1983, 1984b, 1985a,b, 1986a,b, 1987c, 1988b).

3. Biological Data Relevant to the Evaluation of Carcinogenic Risk to Humans

3.1 Carcinogenicity studies in animals¹

The carcinogenicity of chromium and chromium-containing compounds in experimental animals has been reviewed recently (Yassi & Nieboer, 1988; Fairhurst & Minty, 1990).

The description and evaluation of the available carcinogenicity studies in experimental animals have been subdivided into four subsections, mainly according to the chemical and physical properties of different chromium-containing materials: (a) Metallic chromium; (b) chromium [III] compounds; (c) chromium [VI] compounds; and (d) other chromium compounds. Chromium-containing alloys used in implants will be considered in a subsequent volume of *IARC Monographs* (Volume 52), in a monograph on cobalt and cobalt compounds.

(a) *Metallic chromium*

(i) *Intrapleural administration*

Mouse: No tumour was observed after 14 months in a group of 50 male C57Bl mice, approximately six weeks of age, that received six intrapleural injections of 10 µg chromium powder in 0.2 ml of a 2.5% gelatin-saline solution every other week. A total of 32 mice lived for up to 14 months (Hueper, 1955).

Rat: Groups of 17 female and eight male Osborne-Mendel rats, approximately four months old, were given six monthly intrapleural injections of 16.8 mg chromium powder in 50 µl lanolin; and 25 male Wistar rats, of approximately the same age, received six weekly intrapleural injections of 0.5 mg chromium powder suspended in 0.1 ml of a 2.5% gelatin-saline solution. Six Osborne-Mendel rats survived up to 19-24 months and 12 Wistar rats up to 25-30 months. Three female Osborne-Mendel rats developed adenofibromas of the thoracic wall; in addition, one rat also had a retroperitoneal haemangioma. Two other rats [group unspecified] had a haemangioma and an angiosarcoma, and another rat [group unspecified] had an intra-abdominal round-cell sarcoma. Of 12 male Wistar rats receiving gelatin alone, three developed intra-abdominal round-cell sarcomas (Hueper, 1955).

¹The Working Group was aware of carcinogenicity studies in progress with sodium chromate by intraperitoneal administration in mice and rats, with calcium chromate and chromite ore residue by inhalation in rats and with chromium by intratracheal administration in hamsters (IARC, 1988).

(ii) *Intramuscular administration*

Rat: A group of 24 male Fischer rats, eight weeks of age, received a single intramuscular injection of 2 mg chromium dust (elemental Cr, 65%, chromium oxides as Cr₂O₃, 35%; Ni, Al, Cu, Mn and Co, < 0.1%; mean particle diameter, 1.6 µm) suspended in 0.5 ml penicillin G procaine. No local tumour was reported in the 22 survivors at 24 months (Sunderman *et al.*, 1974). [The Working Group noted that only a single low dose was given.]

Two groups of 18 and 20 male Fischer-344 rats, aged eight weeks, received a single intramuscular injection of 4.4 mg chromium dust (Cr, 76%; O₂, 24%; Mn, 0.2%; median particle diameter, 1.4 µm) suspended in 0.2 ml penicillin G procaine. The study was terminated at two years, when 13/18 and 0/20 were still alive in the two groups, respectively; the low survival in the second group was due to an epidemic of pulmonary pneumonia. No local tumour developed in either group (Sunderman *et al.*, 1980). [The Working Group noted that only a single dose was given.]

A group of 25 male and 25 female weanling Fischer-344 rats received monthly intramuscular injections of 100 mg chromium powder (99.9% pure) in 0.2 ml tri-caprylin. Treatment was continued until definite nodules appeared at the injection site in more than one animal [time unspecified]. The study was terminated at 644 days [survival figures not given]. A single injection-site fibrosarcoma was reported in a male rat. No local tumour was seen in 50 vehicle-control rats (Furst, 1971).

(iii) *Intraperitoneal administration*

Mouse: A group of 50 male C57Bl mice, approximately six weeks old, was given weekly intraperitoneal injections for four consecutive weeks of 10 µg chromium powder (diameter, > 100 µm to colloidal particle size) suspended in 0.2 ml of a 2.5% gelatin-saline solution. Forty mice survived up to 21 months, at which time the experiment was terminated. One mouse developed a myeloid leukaemia; no other tumour was noted (Hueper, 1955). [The Working Group noted the low dose given.]

Rat: A group of 25 male Wistar rats, three to four months old, was given weekly intraperitoneal injections for six consecutive weeks of 50 µg chromium powder in 0.1 ml of a 2.5% gelatin-saline solution. One rat developed a scirrhous carcinoma of the caecal submucosa, two rats developed intra-abdominal round-cell sarcomas, one rat had both a sarcoma of the leg of cartilaginous osteoid origin and an insulinoma of the pancreas, and one rat had an insulinoma (Hueper, 1955). [The Working Group noted that no vehicle control group was reported and that the authors stated that, although round-cell sarcomas also occurred in controls, insulinomas were found only in treated rats.]

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(iv) *Intravenous administration*

Mouse: A group of 25 C57Bl mice [sex unspecified], about eight weeks of age, received six weekly injections into the tail vein of 2.5 µg chromium powder (particle size, ≤ 4 µm) in 0.05 ml of a gelatin-saline solution. Six animals lived up to 12 months, but none to 18 months. No tumour was observed (Hueper, 1955).

Rat: A group of 25 male Wistar rats, approximately seven months of age, was given six weekly injections of 90 µg chromium powder in 0.18 ml of a 2.5% gelatin-saline solution into the left vena saphena. Fifteen were still alive at one year and 13 at two years, at which time the study was terminated. Round-cell sarcomas were observed in four rats - three in the ileocaecal region and one in the intrathoracic region. One rat had a haemangioma of the renal medulla, and two rats had papillary adenomas of the lungs, one of which showed extensive squamous-cell carcinomatous changes. Use of vehicle-treated controls was not reported. The author stated that, although round-cell sarcomas also occurred in groups of control rats in this series of studies, lung adenomas were found only in treated rats (Hueper, 1955).

Rabbit: Eight albino rabbits [sex unspecified], approximately six months of age, received six weekly intravenous injections of 25 mg/kg bw chromium powder in 0.5 ml of a 2.5% gelatin-saline solution into the ear vein; the same course of treatment was given four months later; and, three years after the first injection, a third series of injections was given to the three surviving rabbits. Four rabbits given intravenous injections of the vehicle alone served as controls. One of three rabbits that survived six months after the last injection developed a tumour of uncertain origin (apparently an immature carcinoma) involving various lymph nodes, but no tumour occurred in controls (Hueper, 1955).

(v) *Intrafemoral administration*

Rat: A group of 25 male Wistar rats, approximately five months old, received an injection into the femur of 0.2 ml of a 50% (by weight) suspension of chromium powder (approximately 45 mg) in 20% gelatin-saline and was observed for 24 months; 19 survived over one year. No tumour developed at the injection site. Similarly, a group 25 male Osborne-Mendel rats, approximately five months of age, was injected in the femur with a similar dose of chromium powder in 0.2 ml lanolin and observed for 24 months; 14 survived for one year, and one rat developed a fibroma at the injection site (Hueper, 1955).

[The Working Group noted that many of the above studies suffered from various limitations, including the use of low doses, low effective numbers of animals and inadequate reporting.]

(vi) *Administration with known carcinogens*

Rat: Groups of 35-62 female Wistar rats, four to six weeks old, were given one intratracheal instillation of 10 mg powdered chromium (purity, 99.4%; diameter, 1-3 μm) in combination with 1 or 5 mg 20-methylcholanthrene (MC) or MC alone in saline and were killed at various intervals up to 12 weeks. Squamous-cell carcinomas of the lung developed 12 weeks after treatment in 7/12 (58%) rats given Cr + 5 mg MC, in 3/12 (25%) given Cr + 1 mg MC, in 3/7 (43%) given 5 mg MC alone, in 1/8 (12.5%) given 1 mg MC alone and in 0/12 given Cr alone (Mukubo, 1978.) [The Working Group noted the short duration of the study.]

(b) *Chromium[III] compounds*(i) *Intratracheal instillation*

Rat: Random-bred and Wistar rats [age, sex and distribution unspecified] were given single intratracheal instillations of 50 and 20 mg chromic oxide, respectively. Malignant lung tumours developed in 7/34 and 6/18 animals; and four and five of these, respectively, were lung sarcomas, which appeared between 11 and 22 months after treatment (Dvizhkov & Fedorova, 1967). [The Working Group noted that use of controls was not reported and other details were not given.]

(ii) *Intrabronchial administration*

Rat: A group of 98 rats [strain, age and sex unspecified] received implants of intrabronchial stainless-steel mesh pellets (5 \times 1 mm) loaded with 3-5 mg of a 50:50 mixture of chromic oxide with a cholesterol binder. Animals were observed up to 136 weeks. No lung tumour was found in treated or in 24 cholesterol binder-treated controls (Laskin *et al.*, 1970).

Groups of 100 male and female Porton-Wistar rats received intrabronchial pellets loaded with 2 mg chromite ore [purity not given], 2 mg chromic oxide (metallurgical-grade, 99-100% pure), 2 mg chromic chloride hexahydrate (95% pure) or 2 mg chrome tan ($\text{Cr}_2(\text{OH})_2(\text{SO}_4)_2\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$ [purity not given]) suspended 50:50 in cholesterol. The incidence of squamous metaplasia in the left bronchus of treated animals was similar to that in controls. An increased incidence was seen with all five Cr[VI] compounds examined in the same study (see p. 125; Levy & Venitt, 1986).

In a second study using the same technique, no lung tumour was seen in a group of 101 rats treated with high silica chrome ore (TSS 695, containing 46.1% chromic oxide) (Levy *et al.*, 1986).

(iii) *Oral administration*

Mouse: Groups of 54 male and 54 female weanling Swiss mice received 5 mg/l chromic acetate in drinking-water for life. No difference was found in the survival

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of treated females compared with controls, but treated males died earlier than control males (mean survival, 831 *versus* 957 days); only 60% of males survived 18 months. The incidence of tumours in treated animals was no greater than that in controls (Schroeder *et al.*, 1964).

Rat: Chromic acetate was given in drinking-water at a level of 5 mg/l to 46 male and 50 female weanling Long Evans rats for life. At least 70% of the animals survived for up to two years; treated females lived as long as control females, but treated males lived up to 100 days longer than control males. The incidences of tumours at various sites in rats of either sex were not significantly different from those in controls. The total numbers of autopsied animals with tumours were: 16/39 treated males, 18/35 treated females, 9/35 male controls and 15/35 female controls (Schroeder *et al.*, 1965).

Chromic oxide (green) obtained by the reduction of chromate at 600°C was baked in bread with other nutrients at levels of 1, 2 and 5%, and the bread was fed to groups of 60 male and female inbred BD rats, 100 days of age, on five days per week for two years. At the high-dose level, the total dose consumed was about 1800 g/kg bw. Average survival times were 860-880 days. Mammary fibroadenomas were found in three rats given 1%, in one given 2% and in three given 5%. One mammary carcinoma and two fibroadenomas were detected in controls (Ivankovic & Preussmann, 1975).

(iv) *Intrapleural administration*

Mouse: Only granulomas were produced when 10 mg chromite ore dust [$\text{FeO}(\text{CrAl})_2\text{O}_3$] particles (average diameter, 1 μm ; range, 0.1-5 μm) were injected intrapleurally in 0.5 ml distilled water into 25 Balb/c mice [sex and age unspecified]. Animals were killed at intervals from two weeks to 18 months after the injection (Davis, 1972). [The Working Group noted the lack of detailed reporting.]

Rat: A group of 14 male and 11 female Osborne-Mendel rats, four months of age, received six monthly intrapleural injections of 37 mg chromite ore suspended in 0.05 ml lanolin. Thirteen survived one year and all animals were dead at 24 months. One thoracic tumour (fibrosarcoma) was found in a treated animal but none in 25 controls (Hueper, 1955).

A group of 34 rats [strain, sex and age unspecified] received intrapleural implantations of chromic acetate [dose unspecified] in sheep fat. Eighteen rats were still alive at 15 months and 15 at 21 months. One implantation-site tumour [type unspecified] was seen. Of 34 control rats administered sheep fat alone, 30 were alive at one year and 11 at 21 months; none developed a tumour (Hueper, 1961).

A group of 42 Bethesda Black [NIH Black] rats [sex unspecified], approximately three months of age, received eight intrapleural implantations over 13 months of 25 mg chromic acetate in gelatin capsules. No implantation-site tumour

was seen after two years (Hueper & Payne, 1962). [The Working Group noted the lack of controls.]

(v) *Intramuscular administration*

Rat: A group of 34 rats [sex, age and strain unspecified] received intramuscular implantations of chromic acetate [dose unspecified]. Thirty were still alive at one year and 17 at 21 months. One animal developed an injection-site tumour [type unspecified]. Of 32 controls given implants of sheep fat alone 30 were alive at one year and ten at 21 months. None developed a local tumour (Hueper, 1961).

A group of 35 Bethesda Black [NIH Black] rats [sex unspecified], approximately three months of age, received an intramuscular implantation of 25 mg chromic acetate in a gelatin capsule; a further seven intramuscular implantations were made over a period of 24 months, at which time the rats were sacrificed. One spindle-cell sarcoma was observed at the site of implantation (Hueper & Payne, 1962). [The Working Group noted that no control group was reported.]

(vi) *Intraperitoneal administration*

Mouse: In a strain A mouse assay for lung adenomas, three groups of ten male and ten female strain A/Strong mice, six to ten weeks of age, were given intraperitoneal injections of chromic sulfate suspended in tricapylin three times a week for eight weeks (total doses, 480, 1200 and 2400 mg/kg bw). Animals were killed 30 weeks after the first injection. No significant increase in the incidences of pulmonary adenomas over those in 20 vehicle-treated or 20 untreated control mice of each sex was observed (Stoner *et al.*, 1976; Shimkin *et al.*, 1977). [The Working Group noted the small number of animals used.]

Rat: In experiments with Wistar and random-bred rats [sex, age and distribution unspecified], 4/20 animals developed lung sarcomas 16-19 months after a single intraperitoneal injection of 20 mg chromic oxide (Dvizhkov & Fedorova, 1967). [The Working Group noted that no control group was reported.]

(vii) *Intravenous administration*

Mouse: Strain A mice in a group of 25 males and 25 females [age unspecified] were each given an intravenous injection into the tail vein of 5 mg chromite ore (39-60% chromic oxide; particle size, 1.6 μm) suspended in saline. The animals were killed at three, 4.5 and six months. There was no difference in the incidence of pulmonary adenomas between treated mice and 75 untreated controls (Shimkin & Leiter, 1940; Shimkin *et al.*, 1977).

Rabbit: A group of six female albino rabbits, six months of age, received six weekly intravenous injections of 25 mg chromite ore suspended in 5 ml of a 2.5% gelatin-saline solution; treatment was repeated in four of the six rabbits nine months later. The six rabbits died or were killed at 13, 20, 22, 22, 48 and 48 months.

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No tumour was observed during these periods (Hueper, 1955). [The Working Group noted the small number of animals used and the lack of controls.]

(viii) *Intrafemoral administration*

Rat: A group of 15 male and 10 female Osborne-Mendel rats, five months of age, each received an injection into the femur of 0.05 ml of a 50% (by volume) suspension containing about 58 mg chromite ore (44% chromic oxide) in lanolin; 13 survived one year. No tumour developed at the injection site (Hueper, 1955).

(ix) *Administration with known carcinogens*

Rat: Groups of 15 male Fischer 344 rats, seven weeks of age, received drinking-water (distilled) containing 0 or 500 mg/l *N*-nitrosoethylhydroxyethylamine (NEHEA) for two weeks. Thereafter, rats received drinking-water alone or drinking-water containing 600 mg/l chromic chloride hexahydrate (98% pure) for 25 weeks, when the study was terminated. There was no significant increase in the incidence of renal-cell tumours in the group receiving NEHEA and chromic chloride (6/15) over that in the group given NEHEA alone (2/15). No renal tumour was reported in the group receiving chromic chloride alone (Kurokawa *et al.*, 1985). [The Working Group noted that the experiment was not intended as a test for the overall carcinogenicity of chromic chloride.]

(c) *Chromium[VI] compounds*

(i) *Inhalation*

Mouse: Groups of 136 C57Bl/6 mice of each sex, eight weeks old, were exposed by inhalation to calcium chromate dust (reagent grade; particle size, 99.9% < 1.0 μm) at 13 mg/m³ for 5 h per day on five days per week over their lifespan. The median survival time was 93 weeks for treated and 80 weeks for control mice. Six lung adenomas appeared in treated males and eight in females, compared with three and two in the 136 respective controls [$p = 0.04$ for males and females combined]. No carcinoma was seen; no information was given on the occurrence of tumours at other sites (Nettesheim *et al.*, 1971).

A group of 50 female ICR/JcI mice [age unspecified] was exposed by inhalation to chromic acid (chromium trioxide) mist (particle size, 84.5% > 5 μm) generated by a miniaturized electroplating system at a chromium concentration of 3.63 mg/m³ for 30 min per day on two days per week for up to 12 months. Mice surviving at that time were maintained for a further six months; two groups of ten mice killed at 12 and 18 months served as controls. A single lung adenoma was reported in 1/15 mice that died or were killed between six and nine months; lung adenomas occurred in 3/14 mice that died between ten and 14 months; and 1/19 adenoma and 2/19 adenocarcinomas in mice that died at 15-18 months. In the control groups, no lung

tumour was reported in ten mice killed at 12 months, but 2/10 adenomas occurred in those killed at 18 months. The authors observed nasal perforations in six mice exposed for more than ten months and time-related inflammatory changes, including squamous metaplasia, in the trachea and bronchus of exposed mice (Adachi *et al.*, 1986). [The Working Group noted the incomplete reporting of lesions.]

A group of 43 female C57Bl mice [age unspecified] was exposed by inhalation to chromic acid (chromium trioxide) mist (85% of particles $> 5 \mu\text{m}$) generated by a miniaturized electroplating system at a chromium concentration of 1.81 mg/m^3 for 120 min twice a week for 12 months, at which time 23 mice were killed. The remaining 20 were killed six months after the last exposure. Nasal perforation was seen in 3/23 and 3/20 mice killed at 12 and 18 months, respectively; 0/23 and 6/20 nasal papillomas occurred in these groups. A single lung adenoma was reported in the group killed at 18 months. No nasal inflammatory change or lung tumour was seen in a group of 20 untreated control mice (Adachi, 1987). [The Working Group noted the inadequate reporting of lesions.]

Rat: Groups of 20 male TNO-W74 Wistar rats, six weeks of age, were exposed by inhalation to sodium dichromate at 25, 50 or $100 \mu\text{g/m}^3$ Cr (average mass median diameter, $0.36 \mu\text{m}$), produced from an aqueous sodium dichromate solution, for 22-23 h per day on seven days per week for 18 months. The rats were then held for a further 12 months, at which time the study was terminated. A control group consisted of 40 untreated male rats. Survival was about 90% at 24 months; at termination at 30 months, survival was 65, 55, 75 and 57.5% in the 25, 50, $100 \mu\text{g/m}^3$ and control groups respectively. In rats that survived 24 or more months, lung tumours occurred in 0/37, 0/18, 0/18 and 3/19 in the control, 25, 50 and $100 \mu\text{g/m}^3$ groups, respectively. The three lung tumours were two adenomas and an adenocarcinoma; a squamous carcinoma of the pharynx was also reported in this group. The incidence of treatment-related tumours was not increased at other sites (Glaser *et al.*, 1986). [The Working Group noted the small number of animals used.]

(ii) *Intratracheal instillation*

Mouse: A group of 62 strain A mice [sex unspecified], ten to 11 weeks of age, received six intratracheal injections of 0.03 ml of a 0.2% saline suspension of zinc chromate [basic potassium zinc chromate, $\text{K}_2\text{O} \cdot 4\text{ZnO} \cdot 4\text{CrO}_3 \cdot 3\text{H}_2\text{O}$ (Baetjer *et al.*, 1959b)] at six-week intervals and were observed until death. No pulmonary carcinoma was found; pulmonary adenomas occurred in 31/62 exposed, in 7/18 untreated control and 3/12 zinc carbonate-treated control animals (Steffee & Baetjer, 1965).

Groups of 40 male and 40 female Sprague-Dawley rats, ten weeks of age, received intratracheal instillations of 1 ml/kg bw sodium dichromate (99.95% pure) or calcium chromate (chemically pure) in 0.9% sodium chloride solution once a week or five times a week. Equal numbers of male and female rats were used as vehicle

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and untreated controls. Administered doses and schedules are given in Table 20. Treatment and study of all groups was continued for 30 months; median survival was approximately 800 days in the sodium dichromate-treated groups. [The Working Group noted that survival was not reported for the calcium chromate-treated groups.] No lung tumour was reported in the groups treated five times weekly with sodium dichromate. Among animals treated weekly with sodium dichromate, 14/80, 1/80 and 0/80 animals developed lung tumours in the groups receiving 1.25, 0.25 and 0.05 mg/kg bw, respectively, with 0/80 in controls [$p < 0.001$, Cochran-Armitage test for trend]. Of the 14 animals that developed lung tumours after receiving 1.25 mg/kg bw sodium dichromate weekly 12 had adenomas and eight had malignant lung tumours, described as two adenocarcinomas (bronchioalveolar) and six squamous-cell carcinomas. The authors noted that two of the tumours were questionable and that the majority of the observed lung tumours were small, non-metastasizing, non-fatal and co-existed with scarring and other treatment-related inflammatory changes not seen in animals treated five times a week with lower doses. In the groups receiving calcium chromate, similar findings were made, with a total of six lung tumour-bearing rats (five adenomas ($p < 0.01$) and one squamous-cell carcinoma) in the group receiving 0.25 mg/kg bw five times a week, and 13 lung-tumour-bearing rats (11 adenomas ($p < 0.01$) and three with two squamous-cell carcinomas and one adenocarcinoma ($p < 0.01$)) in the group receiving 1.25 mg/kg bw once a week. [The Working Group assumed that one rat had both an adenoma and a squamous-cell carcinoma.] The authors noted that one of the squamous-cell carcinomas may have been a metastasis from a primary tumour of the jaw (Steinhoff *et al.*, 1986).

Hamster: Groups of 35 male Syrian golden hamsters, about six weeks old, received weekly intratracheal instillations of 0.1 mg calcium chromate in 0.2 ml saline for 56 weeks and were maintained for a further 44 weeks. No lung tumour was reported (Reuzel *et al.*, 1986).

Guinea-pig: Groups of 21 or 13 guinea-pigs [sex and strain unspecified], three months of age, received six intratracheal instillations of 0.3 ml of a 1% suspension in saline of 3 mg zinc chromate as basic potassium zinc chromate (Baetjer *et al.*, 1959b) or 3 mg lead chromate, at three-monthly intervals. The animals were observed until death. A single pulmonary adenoma was seen in the group given zinc chromate, but no pulmonary carcinoma. No pulmonary adenoma was seen in the lead chromate group or in 18 vehicle controls (Steffee & Baetjer, 1965). [The Working Group noted the limited reporting of the study.]

Rabbit: Groups of seven rabbits [sex and strain unspecified], four months of age, received three to five intratracheal instillations of 1 ml of a suspension in saline of 1% (10 mg) zinc chromate (basic potassium zinc chromate, Baetjer *et al.*, 1959b) or lead chromate at three-monthly intervals. No lung tumour was reported in

Table 20. Protocol and results of test by intratracheal instillation of various chromium[VI] compounds to rats^a

Compound	No. of animals		Dose (mg/kg bw)	Schedule	No. of lung tumours		Total no. of tumour-bearing animals
	Males	Females ^b			Benign	Malignant	
Sodium dichromate	40	50	0.25	5 × weekly	–	–	–
Sodium dichromate	40	45	0.05	5 × weekly	–	–	–
Sodium dichromate	40	45	0.01	5 × weekly	–	–	–
Sodium dichromate	40	40	1.25	1 × weekly	12*	8*	14
Sodium dichromate	40	40	0.25	1 × weekly	–	1	1
Sodium dichromate	40	40	0.05	1 × weekly	–	–	–
Calcium chromate	40	50	0.25	5 × weekly	5*	1	6
Calcium chromate	40	40	1.25	1 × weekly	11*	3*	13
Benzo[a]pyrene	0	10	5.0	1 × weekly			
Dimethyl carbamoyl chloride	10	10	1.0	1 × weekly			
Sodium chloride (0.9%)	40	50	1 ml/kg	5 × weekly	–	–	–
Sodium chloride (0.9%)	40	40	1 ml/kg	1 × weekly	–	–	–
Untreated	40	50	–	–	–	–	–

^aFrom Steinhoff *et al.* (1986)^bOnly 40 females used for carcinogenicity tests (five to ten extra in test groups)*Significant at $p < 0.01$

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treated animals or in five saline-treated controls (Steffee & Baetjer, 1965). [The Working Group noted the limited reporting of the study.]

(iii) *Intrabronchial administration*

Rat: A group of 100 rats [strain, sex and age unspecified] received intrabronchial implantations of stainless-steel mesh pellets (5×1 mm) loaded with 3-5 mg of a 50:50 mixture of calcium chromate with a cholesterol binder. Six squamous-cell carcinomas and two adenocarcinomas of the lung were found in animals observed up to 136 weeks. The median time to appearance of tumours was 540 days. A group of 100 rats similarly treated with chromium trioxide and observed up to 136 weeks had no such tumour, nor did 24 controls treated with cholesterol binder (Laskin *et al.*, 1970). [Although the incidence of lung tumours was not statistically significant, the Working Group noted the probable biological significance of these tumours.]

Groups of approximately 50 male and 50 female Porton-Wistar rats, six to eight weeks old, received intrabronchial implantations into the left lung of stainless-steel mesh pellets (5×1 mm) loaded with about 2 mg of a series of chromium-containing test materials suspended 50:50 in cholesterol. Groups of approximately 75 male and 75 female rats receiving blank pellets or pellets loaded with cholesterol alone acted as negative controls. Animals were maintained for 24 months, at which time the study was terminated and all lungs and abnormal tissues examined. [The Working Group noted that survival was not reported]. No lung tumour was seen in either control group or among rats receiving pellets loaded with sodium dichromate (99-100% pure) or sodium chromate (98-99% pure); a single squamous-cell carcinoma of the left lung was seen in the group treated with chromic acid (chromium trioxide; 99-100% pure) and eight squamous-cell carcinomas ($p < 0.05$) of the left lung in the group treated with calcium chromate (95% pure). There was a significant increase in the incidence of bronchial squamous metaplasia of the left lung in rats without lung tumours in all treatment groups when compared to the groups receiving cholesterol or a blank pellet. Of animals that received intrabronchial pellets loaded with zinc potassium chromate ($K_2CrO_4 \cdot 3ZnCrO_4 \cdot Zn(OH)_2$, 99-100% pure) suspended in cholesterol, 3/61 developed squamous-cell carcinomas of the left lung (Levy & Venitt, 1986).

In a second study using the techniques and protocol described above, the incidences of squamous-cell carcinomas of the left lung in groups of animals given a range of lead chromates, zinc chromates and strontium chromates were as shown in Table 21. Significance was calculated by comparing the incidence of bronchial carcinomas in each test group with that in a reference group comprising the two negative control groups and all groups treated with chromium-containing materials. Survival was 96% at 400 days and 54% at 700 days. Calcium chromate (96.7% pure), included as a positive control, induced 25/100 left-lung bronchial carcinomas

(24 squamous-cell carcinomas and one adenocarcinoma); chromium trioxide (99.9% pure) induced 2/100 left-lung bronchial carcinomas (one squamous-cell carcinoma and one anaplastic carcinoma); sodium dichromate dihydrate (TSS 612; 99.7% pure) gave 1/100 left-lung squamous-cell carcinoma; and a residue material (vanadium solids) from the bichromate production process, containing 5.3% calcium chromate and 17.2% sodium dichromate, induced 1/100 squamous-cell carcinoma of the left lung. No bronchial carcinoma was seen in the 100 rats given cholesterol alone; and 22/48 bronchial carcinomas (21 squamous-cell carcinomas and one anaplastic carcinoma) were seen in a positive control group receiving 20-methylcholanthrene (Levy *et al.*, 1986).

Table 21. Incidence of bronchial carcinomas in rats administered various chromium[VI] compounds by intrabronchial implantation into the left lung^a

Compound	Composition	Incidence of bronchial carcinomas
Lead chromates		
Lead chromate (99.8% pure)	Pb, 64%; CrO ₄ , 35.8%	1/98
Primrose chrome yellow	Pb, 62.1%; Cr, 12.6%	1/100
Molybdate chrome orange ^b		0/100
Light chrome yellow	Pb, 62.1%; Cr, 12.5%	0/100
Supra (70 FS) LD chrome yellow	PbO, 61.5%; CrO ₃ , 26.9%	1/100
Medium chrome yellow	Pb, 60.2%; Cr, 16.3%	1/100
Silica encapsulated medium chrome yellow	Pb, 40.4%; Cr, 10.5%	0/100
Barium chromate (98% pure)	Ba, 54.1%; CrO ₄ , 42.1%	0/101
Zinc chromate IW (low water solubility)	ZnO, 39.4%; CrO ₃ , 40.8%	5/100 ^c [<i>p</i> = 0.004]
Zinc chromate (Norge composition)	ZnO, 39.2%; CrO ₃ , 43.5%	3/100 ^c [<i>p</i> = 0.068]
Zinc tetroxychromate	Zn, 56.6%; Cr, 8.8%	1/100
Strontium chromate	Sr, 42.2%; CrO ₄ , 54.1%	43/99
Strontium chromate	Sr, 43.0%; Cr, 24.3%	62/99
Cholesterol control		0/100
20-Methylcholanthrene control		22/48

^aFrom Levy *et al.* (1986)

^bComposition incompletely described by Levy *et al.* (1986); it is a mixture of lead chromate, lead sulfate and lead molybdate (Pb, 62.9%; Cr, 12.9%; Mo, 4.2%).

^cSignificance for each treatment group based on a reference group composed of a combination of the negative control group and all groups treated with chromate-containing materials, except those treated with calcium or strontium chromate

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(iv) *Intrapleural administration*

Rat: A number of chromium[VI] compounds [doses unspecified] administered to rats [sex, age and strain unspecified] by intrapleural implantation in experiments lasting 27 months gave the following numbers of implantation-site tumours [type unspecified]: strontium chromate, 17/28 (nine alive at one year); barium chromate, 1/31 (30 alive at one year); lead chromate, 3/34 (32 alive at one year); zinc yellow [unspecified composition], 22/33 (11 alive at one year); calcium chromate, 20/32 (none alive at one year); sintered calcium chromate, 17/33 (nine alive at one year, one alive at 21 months); and sodium dichromate, 0/26 (20 alive at one year, none alive at 18 months). None of 34 control rats had tumours (30 alive at one year, five alive at two years) (Hueper, 1961).

Groups of 20 male and 19 female Bethesda Black [NIH Black] rats, three months of age, received 16 monthly intrapleural injections of 2 mg sodium dichromate in gelatin and were observed for up to two years. One adenocarcinoma of the lung was observed; no tumour at the injection site was observed in 60 control rats treated with gelatin solution. After intrapleural implantation of 12.5 mg calcium chromate in a gelatin capsule to 14 rats, eight developed malignant tumours [type unspecified] at the site of implantation after two years compared with none in 35 controls (Hueper & Payne, 1962).

(v) *Subcutaneous administration*

Mouse: A group of 26 female and 26 male C57Bl mice received calcium chromate or sintered calcium chromate (prepared by heating calcium chromate with less than 1% impurities to about 1100°C for about 1 h) by subcutaneous injection of 10 mg chromium compound in tricapylin, and the animals were observed for 18-26 months. One sarcoma was observed in 13 mice treated with calcium chromate that lived longer than six months, but none was seen at the injection site in the other treated groups or in vehicle controls. Histologically, the injection-site tumours were spindle-cell sarcomas or fibrosarcomas (Payne, 1960a).

Rat: Groups of 40 male and female Sprague-Dawley rats, 13 weeks of age, received a single subcutaneous injection of 30 mg lead chromate (chromium yellow) or basic lead chromate (chromium orange) in water. Sarcomas (rhabdomyosarcomas and fibrosarcomas) developed at the injection site in 26/40 and 27/40 animals, respectively, within 117-150 weeks. No local tumour occurred in 60 vehicle-control rats, and a single local sarcoma occurred in 80 control rats that received comparable subcutaneous injections of iron yellow or iron red (Maltoni, 1974, 1976; Maltoni *et al.*, 1982).

Groups of 20 male and 20 female Sprague-Dawley rats, 13 weeks of age, received single subcutaneous injections of 30 mg zinc yellow (basic zinc chromate) at 20% or 40% CrO_3 in 1 ml saline. Local sarcomas (rhabdomyosarcomas and fibrosarcomas) were seen in 6/40 and 7/40 rats given 20% and 40% CrO_3 at 110 and 137 weeks, respectively. No local tumour had occurred in the 40 control animals by 136 weeks (Maltoni *et al.*, 1982).

A further group of 20 male and 20 female Sprague-Dawley rats received single subcutaneous injections of 30 mg molybdenum orange (described as a mixture of lead chromate, sulfate and molybdate) in 1 ml saline. At termination of the study at 117 weeks, 36/40 rats had injection-site sarcomas; no local tumour occurred in 45 male and 15 female untreated controls (Maltoni, 1974; Maltoni *et al.*, 1982).

(vi) *Intramuscular administration*

Mouse: Groups of 26 female and 26 male C57Bl mice [age unspecified] received calcium chromate or sintered calcium chromate (prepared by heating calcium chromate with less than 1% impurities to about 1100°C for about 1 h) by intramuscular implantation of 10 mg of the chromium compound mixed with 20 mg sheep fat. Animals were observed for a total of 14 months. Nine implantation-site sarcomas were observed among 46 mice given sintered calcium chromate that lived longer than six months; one sarcoma was observed in 50 mice given non-sintered calcium chromate; and no sarcoma was found among 50 control mice that lived six months or more (Payne, 1960a).

A group of 25 female NIH-Swiss weanling mice was given intramuscular injections of 3 mg lead chromate in trioctanoin every four months. Two lymphomas were seen within 16 months and three lung adenocarcinomas within 24 months among 17 mice that were necropsied. The incidences of these tumours were 1/15 and 1/15 in untreated control mice and 2/22 and 1/22 among vehicle-injected control mice (Furst *et al.*, 1976).

Rat: Groups of 35 Bethesda Black [NIH Black] male and female rats, approximately three months of age, received an intramuscular implantation of pellets containing 25 mg calcium chromate (99% pure), 25 mg sintered calcium chromate or 25 mg sintered chromium trioxide, all in 50 mg sheep fat. Sarcomas (spindle-cell sarcomas and fibrosarcomas) at the implantation site were seen after 12-14 months in 8/35 rats given calcium chromate, 8/35 given sintered calcium chromate and 15/35 given sintered chromium trioxide. No local tumour was seen in 35 controls or in groups of 20 males and 15 females given implants of 25 mg barium chromate (99% pure) in 50 mg sheep fat (Hueper & Payne, 1959). [The Working Group noted that sintered chromium trioxide at 1100°C would contain appreciable amounts of chromic chromate; it also noted the short duration of the experiment.]

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In groups of 32-34 rats [sex, strain and age unspecified] that received intramuscular implantation of various chromium compounds in sheep fat [doses unspecified], the following incidences of implantation-site tumours [type unspecified] were recorded after 27 months: calcium chromate, 9/32 (22 alive at one year, seven alive at two years); sodium dichromate, 0/33 (25 alive at one year, 16 alive at 18 months); sintered calcium chromate, 12/34 (22 alive at one year, none alive at two years); strontium chromate, 15/33 (20 alive at one year); barium chromate, 0/34 (30 alive at one year); lead chromate, 1/33 (28 alive at one year); and zinc yellow [composition unspecified], 16/34 (22 alive at one year). None of 32 control rats given implants of sheep fat alone developed local tumours (30 alive at one year, six alive at two years) (Hueper, 1961).

A group of 20 male and 19 female Bethesda Black [NIH Black] rats, three months of age, was given 16 intramuscular injections of 2 mg sodium dichromate in gelatin at monthly intervals and observed for two years (17 alive at 16 months). No tumour appeared at the injection site. After intramuscular implantation of 12.5 mg calcium chromate in a gelatin capsule to eight rats, four malignant tumours developed at the implantation site in animals observed for two years; compared with none in 35 controls (Hueper & Payne, 1962).

Each of a group of 24 male CB stock rats, five to six weeks of age, was given an intramuscular injection of calcium chromate in arachis oil (total dose, 19 mg) once a week for 20 weeks. Eighteen developed spindle-cell or pleomorphic-cell sarcomas at the injection site, none of which metastasized [$p < 0.01$]. The mean time to tumour appearance was 323 days (duration of experiment, 440 days). No tumour developed in 15 control rats given arachis oil only that were alive at 150 days (Roe & Carter, 1969).

Groups of 25 male and 25 female weanling Fischer-344 rats received intramuscular injections of 8 mg lead chromate suspended in trioctanoin once a month for nine months or 4 mg calcium chromate in the same vehicle once a month for 12 months. Lead chromate induced 14 fibrosarcomas and 17 rhabdomyosarcomas at the site of injection in 31/47 rats. In addition, renal carcinomas were observed in 3/23 male rats at 24 months. Calcium chromate induced tumours (three fibrosarcomas, two rhabdomyosarcomas) in 5/45 animals. No such tumour appeared in a group of 22 controls injected with the vehicle (Furst *et al.*, 1976). [The Working Group noted that the renal tumours might be attributable to the lead content of the compound (IARC, 1980b)].

(d) *Other chromium compounds*

(i) *Inhalation*

Mouse: Groups of mice, eight to ten weeks of age, were exposed in dust chambers for 4 h per day on five days per week to a mixed chromium dust¹ containing 1-2 mg/m³ soluble chromium (as chromium trioxide) until they died or were killed (total dose of chromium trioxide inhaled, 272-1330 mg-h): 127 Swiss females were exposed for up to 58 weeks, ten Swiss males and 11 Swiss females for up to 39 weeks, 34 strain A females for 16 weeks, 45 strain A females for 24 weeks, 110 strain A females for 38 weeks, 52 strain A males for 46 weeks, 50 C57Bl males for 42 weeks and 61 C57Bl females for 41 weeks. No lung carcinoma was observed, and the incidence of lung adenomas did not significantly exceed that in control mice in any strain. The experiment lasted for up to 101 weeks (Baetjer *et al.*, 1959b). [The Working Group noted the low doses and the small numbers of animals used.]

Rat: A group of 78 Wistar rats [sex unspecified], six to eight weeks of age, was exposed by inhalation to a mixed chromium dust¹ for 4-5 h per day on four days a week for life, to give an average chromium trioxide concentration of 3-4 mg/m³. No significant difference in tumour incidence was observed between treated and control groups. A group of 38 Sherman rats [sex unspecified], six to eight weeks of age, received 16 monthly intratracheal injections of 0.1 ml of a suspension consisting of 0.5% mixed chromium dust plus 0.6% potassium dichromate, equivalent to 0.07 mg chromium/dose. No lung tumour occurred (Steffee & Baetjer, 1965).

A group of 20 male TNO-W74 Wistar rats, six weeks of age, was exposed by inhalation to 100 µg/m³ pyrolysed Cr[VI]/Cr[III] oxides (3:2; average mass median diameter, 0.39 µm) for 22-23 h per day on seven days a week for 18 months. The rats were then held for a further 12 months. A control group consisted of 40 untreated male rats. Survival was over 90% at 24 months and at 30 months was 50% and 42% in treated and controls, respectively. A single lung adenoma was found in the treated group and none in the controls (Glaser *et al.*, 1986). [The Working Group noted the small number of animals used].

¹The Working Group noted that, in the publications of Baetjer *et al.*, the mixed chromium dust used was prepared by grinding to a fine powder the roast that is produced when chromite ore is heated at a high temperature with sodium carbonate and calcium hydroxide. The mixture contained approximately 12% chromium, consisting of water-soluble sodium chromate (chromium[VI]), water-insoluble but acid-soluble chromium[VI] and [III] chemicals and some unchanged chromite ore; to this mixture was added 1% potassium bichromate. The final analysis of the dust gave 13.7% chromium trioxide and 6.9% chromic oxide. The Working Group commented that this roasted mixture, known as 'frit', is the product of the first stage of the bichromate production process prior to leaching. This first-stage process may or may not involve the addition of calcium hydroxide or limestone.

Groups of 120 male and 120 female Sprague-Dawley rats, six to seven weeks of age, were exposed by inhalation to 0.5 mg/m³ 'unstabilized', 0.5 or 25 mg/m³ 'stabilized' chromium[IV] dioxide particles (mass median aerodynamic diameter, 2.6-2.8 µm) for 6 h a day on five days per week for two years. Ten rats from each group were killed at 12 months for interim observation. Between 101 and 108 lungs were examined for each group exposed up to 24 months. [The Working Group noted that no survival data were reported.] In the 25 mg/m³ stabilized group, there was treatment-related alveolar bronchiolization. In addition, lung adenomas occurred in 1/106 males and 1/108 females in this group, and keratin cysts and 'cystic keratinized squamous-cell carcinomas' in 108 females. The authors considered that the cystic keratinized squamous-cell carcinomas were related to a dust reaction alone and were not true malignant tumours (Lee *et al.*, 1988). [The Working Group noted that similar lesions of the lung were described in a previous *IARC Monograph* on titanium dioxide (IARC, 1989).]

Guinea-pig: Three-month-old guinea-pigs [sex unspecified] were exposed by inhalation to a combination of mixed chromium dust¹ for 4-5 h per day on four days per week for lifespan (average dose, 3-4 mg/m³ chromic trioxide); 3/50 developed pulmonary adenomas. No pulmonary adenoma occurred in 44 controls (Steffee & Baetjer, 1965).

Rabbit: Eight rabbits [sex and strain unspecified], four months of age, were exposed by inhalation for 4-5 h per day on four days per week for up to 50 months to mixed chromium dust¹ according to a complex dosage schedule (average dose, 3-4 mg/m³ chromium trioxide). No pulmonary tumour was seen (Steffee & Baetjer, 1965).

(ii) *Intratracheal instillation*

Mouse: Five to six intratracheal instillations of a mixed chromium dust¹, equivalent to 0.04 mg chromium trioxide per instillation, were given either to 14 and 20 Swiss males, which were then observed for 26 and 32 weeks, respectively; to 45 and 110 Swiss females, observed for up to 32 and 48 weeks, respectively; to 28, 52, 77 and 48 strain A females observed for up to 31, 37, 43 and 52 weeks respectively; to 17 strain A males observed for up to 52 weeks; or to 48 C57Bl males and 47 C57Bl females observed for up to 32 weeks. Treated animals developed no more lung tumours than did untreated control animals (Baetjer *et al.*, 1959b).

Guinea-pig: Groups of 19 guinea-pigs [sex unspecified], three months old, were given six intratracheal instillations of 0.3 ml of a 1% suspension in saline of a mixed chromium dust¹ or a pulverized residue dust (roast material from which solu-

¹See footnote on p. 130

ble chromates had been leached) at intervals of three months. The animals were observed until they died. No pulmonary carcinoma developed in any experimental group or in 18 vehicle controls (Steffee & Baetjer, 1965).

Rabbit: Groups of rabbits received three to five intratracheal injections of 1 ml of a 1% suspension in saline of mixed chromium dust (ten rabbits) or 'pulverized residue dust' (roast material from which soluble chromates had been leached) (seven rabbits) at intervals of three months. No pulmonary tumour was seen in either group (Steffee & Baetjer, 1965).

(iii) *Intrabronchial administration*

Rat: A group of 100 rats [strain, sex and age unspecified] received intrabronchial implants of stainless-steel mesh pellets (5×1 mm) loaded with 3-5 mg of a 50:50 mixture of a chromate process residue (an intermediate process residue from the bichromate-producing industry, which may have contained up to 3% calcium) with a cholesterol binder. Animals were observed up to 136 weeks. One squamous-cell carcinoma was observed after 594 days in 1/93 rats that lived more than 150 days. No lung tumour was seen in 24 cholesterol binder-treated controls (Laskin *et al.*, 1970).

In a study using intrabronchial implantation, described previously (p. 125), no bronchial tumour was seen in five groups of 100 Porton-Wistar rats that received pellets loaded with five residues from bichromate production: Bolton high lime residue, residue after alumina precipitation, residue from slurry tank (free of soluble chromium), residue from vanadium filter and residue from slurry disposal tank. All five materials contained less than 5% hexavalent chromium (Levy & Venitt, 1986; Levy *et al.*, 1986).

In a second study using the technique described above, but examining bichromate production residues containing lime, the following incidences of squamous-cell carcinomas of the left lung were seen: high lime residue from old tip (TSS 643D; Cr_2O_3 , 2.4%; CaCrO_4 , 2.7%; Na_2CrO_4 , 1.0%), 1/99; kiln frit (TSS 643B, with 2% limestone added to feedmix; Cr_2O_3 , 13.0%; Na_2CrO_4 , 29.0%), 2/100; and recycled residue (TSS 643C, with 2% limestone added to feedmix; Cr_2O_3 , 20.4%; Na_2CrO_4 , 2.2%), 0/100 (Levy *et al.*, 1986).

(iv) *Intrapleural administration*

Mouse: Groups of 30 male and 25 female strain A mice, eight to ten weeks of age, were given four intrapleural injections of 0.05 ml of a 2 or 4% suspension of mixed chromium dust¹ in olive oil at intervals of four to six weeks. The incidence of

¹See footnote on p. 130.

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lung tumours during an observation period of 38 weeks was similar to that in a control group of 23 males and 18 females (Baetjer *et al.*, 1959b).

Rat: A group of 25 male Bethesda Black [NIH Black] rats, three months of age, received sheep-fat cubes containign 25 mg roasted chromite ore implanted into the pleural cavity. Squamous-cell carcinomas of the lungs were observed in 2/24 rats that survived 19-24 months. One lung adenoma occurred in the 4/15 female controls given an implant of sheep fat that survived this period (Hueper, 1958). [The Working Group noted that the roasted chromite ore tested in this study was a process-derived material that contained unspciated chromium compounds formed during oxidative heating of a chromium ore that had been subjected to alkaline leaching. Hueper sometimes referred to this material as 'chromate' and sometimes as 'chromite'.]

Of a group of 32 rats [age, sex and strain unspecified] that received intrapleural implantations of chromite roast residue [amount unspecified], 5/32 (28 alive at one year, ten alive at 24 months) developed malignant tumours at the implantation site. In a group of 34 rats given chromic chromate [precise chemical nature unspecified], 25 tumours developed at the implantation site. None of 34 control rats had a tumour (30 alive at one year, five alive at 24 months) (Hueper, 1961).

When 25 mg roasted chromite ore in 50 mg sheep fat (equivalent to 2 mg Cr) were implanted intrapleurally into 15 male and 20 female Bethesda Black rats [age unspecified], implantation-site sarcomas occurred in three rats over 17 months. No tumour was seen in 35 rats injected intrapleurally with the sheep-fat vehicle only (Payne, 1960b)

(v) *Intramuscular administration*

Mouse: A group of 26 male and 26 female C57Bl mice [age unspecified] was given intramuscular implantations of 10 mg roasted chromite ore (equivalent to 0.79 mg chromium) in sheep fat. None developed tumours at the implantation site within 22 months. No local tumour developed in 52 controls treated with sheep fat alone (Payne, 1960b). [The Working Group noted that no data on survival were reported.]

Rat: A group of 31 female Bethesda Black [NIH Black] rats, approximately three months old, was given intramuscular implants of small cubes composed of 25 mg roasted chromite ore suspended in 75 mg sheep fat. Three rats developed fibrosarcomas at the site of implantation within 24 months. No implantation-site tumour occurred in 15 vehicle-treated controls (Hueper, 1958).

In a group of 34 rats [age, sex and strain unspecified] that received intramuscular implantations of chromite roast residue, 1/34 (32 alive at one year, two alive at 27 months) developed a malignant tumour at the injection site [type unspecified]. In a further group of 22 rats given intramuscular implantations of chromic chromate [precise chemical nature unspecified], 24 local tumours were observed after 24

months. None of 32 controls given implants of sheep fat alone developed local tumours (30 alive at one year, six alive at 24 months) (Hueper, 1961).

(vi) *Injections into subcutaneously implanted tracheal grafts*

Rat: Seventy-two tracheal rings excised from female Wistar-Lewis rats were implanted subcutaneously into the backs of 13 rats of the same strain (weighing 100-150 g at the start of the experiment). Two weeks later, the grafts were filled by injection with 0.05 ml of an agar suspension of 2.5 mg chromium carbonyl with or without 2.5 mg benzo[a]pyrene. Biopsies were performed at intervals. Ten squamous-cell carcinomas developed in 24 tracheas that received the mixture, and two carcinomas developed in 22 tracheas treated with chromium carbonyl alone. Three of the tracheal carcinomas produced by the mixture metastasized within nine months. The time to appearance of the tumours was four to 14 months. No tumour occurred in the four trachea that received the vehicle only (Lane & Mass, 1977).

The experiments described in section 3.1 are summarized in Table 22, by compound.

Table 22. Summary of studies used to evaluate the carcinogenicity to experimental animals of metallic chromium and chromium compounds

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
<i>Metallic chromium</i>				
Chromium	Intratracheal	Rat (53)	0/12	Mukubo (1978)
Chromium	Intrapleural	Mouse (50)	0/50	Hueper (1955)
Chromium	Intrapleural	Rat/2 groups (25; 25)	A few tumours, also in controls	Hueper (1955)
Chromium	Intramuscular	Rat (24)	0/22 local tumour	Sunderman <i>et al.</i> (1974)
Chromium	Intramuscular	Rat (38)	0/38 local tumour	Sunderman <i>et al.</i> (1980)
Chromium	Intramuscular	Rat (50)	1/50 vs 0/50	Furst (1971)
Chromium	Intraperitoneal	Mouse (50)	0/50 local tumour	Hueper (1955)
Chromium	Intraperitoneal	Rat (25)	5/25 (mixed)	Hueper (1955)
Chromium	Intravenous	Mouse (25)	0/25	Hueper (1955)
Chromium	Intravenous	Rat (25)	6/25 (mixed)	Hueper (1955)
Chromium	Intravenous	Rabbit (8)	1/3 vs 0/4	Hueper (1955)
Chromium	Intrafemoral	Rat/2 groups (25; 25)	0/25; 1/25 local tumour	Hueper (1955)

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Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
<i>Chromium[III] compounds</i>				
Chromic acetate	Drinking-water	Mouse (108)	M 6/39 vs 11/44 F 9/29 vs 22/60	Schroeder <i>et al.</i> (1964)
Chromic acetate	Drinking-water	Rat (96)	M 16/39 vs 9/35 F 18/35 vs 15/35	Schroeder <i>et al.</i> (1965)
Chromic acetate	Intrapleural	Rat (34)	1/34 vs 0/34	Hueper (1961)
Chromic acetate	Intrapleural	Rat	0/42 local tumour	Hueper & Payne (1962)
Chromic acetate	Intramuscular	Rat (34)	1/34 vs 0/32 local tumour	Hueper (1961)
Chromic acetate	Intramuscular	Rat (35)	1/35 local tumour	Hueper & Payne (1962)
Chromic oxide	Oral (in bread)	Rat (3 groups of 60)	As controls	Ivankovic & Preussman (1975)
Chromic oxide	Intratracheal	Rat (?)	Malignant lung tumours 7/34 (50 mg) and 6/18 (20 mg)	Dvizhkov & Fedorova (1967)
Chromic oxide	Intrabronchial	Rat (98)	0/98 vs 0/24	Laskin <i>et al.</i> (1970)
Chromic oxide	Intrabronchial	Rat (100)	0/100 vs reference ^b	Levy & Venitt (1986)
Chromic oxide	Intraperitoneal	Rat (?)	Lung sarcomas 4/20	Dvizhkov & Fedorova (1967)
Chromic chloride hexahydrate	Intrabronchial	Rat (100)	0/100 vs reference ^b	Levy & Venitt (1986)
Chromic chloride	Drinking-water	Rat (15)	0/15	Kurokawa <i>et al.</i> (1985)
Chrome tan	Intrabronchial	Rat (100)	0/100 vs reference ^b	Levy & Venitt (1986)
Chromic sulfate	Intraperitoneal	Mouse (10 per group; 3 dose levels)	As controls	Stoner <i>et al.</i> (1976)
Chromite	Intrabronchial	Rat (100)	0/100 vs reference ^b	Levy & Venitt (1986)

Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Chromite (high silica chrome ore TSS 645)	Intrabronchial	Rat	0/99 vs reference ^b	Levy <i>et al.</i> (1986)
Chromite	Intrapleural	Mouse (25)	0/25	Davis (1972)
Chromite	Intrapleural	Rat (25)	1/25 vs 0/25	Hueper (1955)
Chromite	Intravenous	Mouse (50)	As controls	Shimkin & Leiter (1940)
Chromite	Intravenous	Rabbit (6)	0/6	Hueper (1955)
Chromite	Intrafemoral	Rat (25)	0/25 local tumour	Hueper (1955)
<i>Chromium[VI] compounds</i>				
Calcium chromate	Inhalation	Mouse (136)	Lung adenomas M 6/136 vs 3/136 F 8/136 vs 2/136	Nettesheim <i>et al.</i> (1971)
Calcium chromate	Intrabronchial	Rat (100)	Bronchial carcinomas 8/100 vs 0/24 (NS)	Laskin <i>et al.</i> (1970)
Calcium chromate	Intrabronchial	Rat (100)	Squamous-cell carcinomas 8/84 vs reference ^b $p < 0.05$	Levy & Venitt (1986)
Calcium chromate	Intrabronchial	Rat (100)	Bronchial carcinomas 25/100 ($p < 0.01$) positive control	Levy <i>et al.</i> (1986)
Calcium chromate	Intratracheal	Rat (80)	Lung: 5 x weekly; 0.25 mg/kg 6/80 vs 0/80 ($p < 0.01$) Lung: 1 x weekly; 1.25 mg/kg 13/80 vs 0/80 ^c ($p < 0.01$)	Steinhoff <i>et al.</i> (1986)
Calcium chromate	Intratracheal	Hamster (35)	No lung tumour	Reuzel <i>et al.</i> (1986)
Calcium chromate	Intramuscular	Mouse (52)	1/50 vs 0/50 local tumour (NS)	Payne (1960a)
Calcium chromate sintered	Intramuscular	Mouse (52)	9/46 vs 0/50 local tumours [$p < 0.01$]	Payne (1960a)
Calcium chromate	Intramuscular	Rat	9/32 vs 0/32 local tumours [$p < 0.01$]	Hueper (1961)
Calcium chromate sintered	Intramuscular	Rat	12/34 vs 0/32 local tumours [$p < 0.01$]	Hueper (1961)

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Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Calcium chromate	Intramuscular	Rat (50)	5/45 vs 0/22 local tumours (NS)	Furst <i>et al.</i> (1976)
Calcium chromate	Intramuscular	Rat (8)	4/8 vs 0/35 local tumours	Hueper & Payne (1962)
Calcium chromate	Intramuscular	Rat (24)	18/24 vs 0/15 local tumours [$p < 0.01$]	Roe & Carter (1969)
Calcium chromate	Intramuscular	Rat (35)	8/35 vs 0/35 [$p < 0.01$]	Hueper & Payne (1959)
Calcium chromate sintered	Intramuscular	Rat (35)	8/35 vs 0/35 [$p < 0.01$]	Hueper & Payne (1959)
Calcium chromate	Intraperitoneal	Rat (14)	8/14 vs 0/35 local tumours	Hueper & Payne (1962)
Calcium chromate	Intraperitoneal	Rat (?)	20/32 vs 0/34 [$p < 0.01$]	Hueper (1961)
Calcium chromate sintered	Intraperitoneal	Rat (?)	17/33 vs 0/34 [$p < 0.01$]	Hueper (1961)
Calcium chromate	Subcutaneous	Mouse (52)	1/13 vs 0/52 (NS)	Payne (1960a)
Calcium chromate sintered	Subcutaneous	Mouse (52)	0/31 vs 0/52	Payne (1960a)
Chromic acid (chromium trioxide)	Inhalation	Mouse (50)	Lung adenomas, 10-14 months: 3/14 vs 0/10 (NS) Adenomas, 15-18 months: 1/19 vs 2/10 Adenocarcinoma: 2/19 vs 0/10 (NS)	Adachi <i>et al.</i> (1986)
Chromic acid (chromium trioxide)	Inhalation	Mouse (43)	Nasal papilloma, 18 months: 6/20 vs 0/20 ($p < 0.05$); 1/20 adenoma of lung	Adachi (1987)
Chromic acid (chromium trioxide)	Intrabronchial	Rat (100)	Squamous-cell carcinoma: vs reference ^b (NS)	Levy & Venitt (1986)
Chromic acid (chromium trioxide)	Intrabronchial	Rat (100)	Bronchial carcinoma: 2/100 vs 0/100 (NS)	Levy <i>et al.</i> (1986)
Chromic acid (chromium trioxide)	Intrabronchial	Rat (100)	Lung: 0/100 vs 0/24	Laskin <i>et al.</i> (1970)
Chromic oxide sintered	Intramuscular	Rat (35)	15/35 local tumours	Hueper & Payne (1959)

Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Sodium dichromate	Inhalation	Rat (20 per group)	Lung tumours: controls, 0/37 25 µg, 0/18 50 µg, 0/18 100 µg, 3/19 (2 adenomas) 1 adenocarcinoma + 1 squamous-cell carcinoma of pharynx	Glaser <i>et al.</i> (1986)
Sodium dichromate	Intrabronchial	Rat (100)	0/89 vs reference ^b	Levy & Venitt (1986)
Sodium dichromate	Intrabronchial	Rat (100)	Bronchial carcinoma: 1/100 vs 0/100 (NS)	Levy <i>et al.</i> (1986)
Sodium dichromate	Intratracheal	Rat (80)	5 × weekly: 0/80 in all groups 1 × weekly: control, 0/80; 0.05 mg/kg, 0/80; 0.25 mg/kg, 1/80; 1.25 mg/kg, 14/80 ^c (<i>p</i> < 0.01)	Steinhoff <i>et al.</i> (1986)
Sodium dichromate	Intrapleural	Rat (39)	Lung adenocarcinoma: 1/34	Hueper & Payne (1962)
Sodium dichromate	Intrapleural	Rat (?)	0/26 vs 0/34 local tumour	Hueper (1961)
Sodium dichromate	Intramuscular	Rat (39)	0/39 local tumour	Hueper & Payne (1962)
Sodium dichromate	Intramuscular	Rat	0/33 vs 0/32 local tumour	Hueper (1961)
Sodium chromate	Intrabronchial	Rat (100)	Lung: 0/89 vs reference ^b	Levy & Venitt (1986)
Bichromate residue (vanadium solids)	Intrabronchial	Rat (100)	Bronchial carcinoma: 1/100 vs reference ^b	Levy <i>et al.</i> (1986)
<i>Zinc chromates</i>				
Basic potassium zinc chromate	Intratracheal	Mouse (62)	Pulmonary adenomas: 31/62 vs 7/18	Steffee & Baetjer (1965)
Basic potassium zinc chromate	Intratracheal	Guinea-pig (21)	Pulmonary adenomas: 1/21 vs 0/18	Steffee & Baetjer (1965)

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Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Basic potassium zinc chromate	Intratracheal	Rabbit (7)	0/7 vs 0/5	Steffee & Baetjer (1965)
Zinc potassium chromate	Intrabronchial	Rat (100)	Squamous-cell carcinoma: 3/61 vs reference ($p < 0.05$)	Levy & Venitt (1986)
Zinc chromate (IW)	Intrabronchial	Rat (100)	Lung: 5/100 vs reference ^b [$p = 0.004$]	Levy <i>et al.</i> (1986)
Zinc chromate (Norge)	Intrabronchial	Rat (100)	3/100 vs reference ^b [$p = 0.068$] NS according to authors	Levy <i>et al.</i> (1986)
Zinc tetroxychromate	Intrabronchial	Rat (100)	1/100 vs reference ^b (NS)	Levy <i>et al.</i> (1986)
Zinc yellow	Intrapleural	Rat	22/33 vs 0/34	Hueper (1961)
Zinc yellow	Subcutaneous	Rat (40)	Local tumours: control, 0/40 20% CrO ₃ , 6/40 40% CrO ₃ , 7/40	Maltoni <i>et al.</i> (1982)
Zinc yellow	Intramuscular	Rat	16/34 vs 0/32	Hueper (1961)
<i>Lead chromates</i>				
Lead chromate	Intrabronchial	Rat (100)	Bronchial carcinoma: 1/98 vs 0/100 (NS)	Levy <i>et al.</i> (1986)
Primrose chrome yellow	Intrabronchial	Rat (100)	1/100 vs reference ^b (NS)	Levy <i>et al.</i> (1986)
Molybdate chrome orange	Intrabronchial	Rat (100)	0/100	Levy <i>et al.</i> (1986)
Molybdenum orange	Subcutaneous	Rat (40)	36/40 vs 0/60	Maltoni (1974); Maltoni <i>et al.</i> (1982)
Light chrome yellow	Intrabronchial	Rat (100)	0/100	Levy <i>et al.</i> (1986)
Supra LC chrome yellow	Intrabronchial	Rat (100)	1/100 vs reference ^b (NS)	Levy <i>et al.</i> (1986)
Medium chrome yellow	Intrabronchial	Rat (100)	1/100 vs reference ^b	Levy <i>et al.</i> (1986)
Silica encapsulated	Intrabronchial	Rat (100)	0/100 (NS)	Levy <i>et al.</i> (1986)
Lead chromate	Intratracheal	Guinea-pig (13)	0/13	Steffee & Baetjer (1965)

Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Lead chromate	Intrapleural	Rat	3/34 vs 0/34	Hueper (1961)
Lead chromate	Intramuscular	Mouse (25)	Lymphoma, lung adenocarcinoma: not different from controls	Furst <i>et al.</i> (1976)
Lead chromate	Subcutaneous	Rat (40)	26/40 vs 0/60 and 1/80 local tumours	Maltoni (1974, 1976); Maltoni <i>et al.</i> (1982)
Basic lead chromate	Subcutaneous	Rat (40)	27/40 vs 0/60 and 1/80 local tumours	Maltoni (1974, 1976); Maltoni <i>et al.</i> (1982)
Lead chromate	Intramuscular	Rat (50)	31/47 vs 0/22 local tumours and 3/23 M vs 0/22 renal carcinomas	Furst <i>et al.</i> (1976)
Lead chromate	Intramuscular	Rat	1/33 vs 0/32 local tumour	Hueper (1961)
Barium chromate	Intrabronchial	Rat (101)	0/101	Levy <i>et al.</i> (1986)
Barium chromate	Intrapleural	Rat (?)	1/31 vs 0/34	Hueper (1961)
Barium chromate	Intramuscular	Rat (?)	0/34 vs 0/32 local tumour	Hueper (1961)
Barium chromate	Intramuscular	Rat (35)	0/35	Hueper & Payne (1959)
Strontium chromate	Intrabronchial	Rat (100)	Bronchial carcinoma: 43/99 vs reference ^b	Levy <i>et al.</i> (1986)
Strontium chromate	Intrabronchial	Rat (100)	Bronchial carcinoma: 64/99 vs reference ^b	Levy <i>et al.</i> (1986)
Strontium chromate	Intrapleural	Rat (?)	17/28 vs 0/34	Hueper (1961)
Strontium chromate	Intramuscular	Rat	15/33 vs 0/32 local tumour	Hueper (1961)
<i>Other chromium compounds and chromium-containing mixtures</i>				
Mixed chromium dust	Inhalation	Mouse (500)	As controls	Baetjer <i>et al.</i> (1959b)
Mixed chromium dust	Inhalation	Rat (78)	As controls	Steffee & Baetjer (1965)

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Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Mixed chromium dust	Inhalation	Guinea-pig (50)	Pulmonary adenomas: 3/50 vs 0/44	Steffee & Baetjer (1965)
Mixed chromium dust	Inhalation	Rabbit (8)	0/8 local tumour	Steffee & Baetjer (1965)
Mixed chromium dust	Intratracheal	Mouse (506)	As controls	Baetjer <i>et al.</i> (1959b)
Mixed chromium dust	Intratracheal	Guinea-pig (19)	0/19 vs 0/18	Steffee & Baetjer (1965)
Mixed chromium dust plus K ₂ Cr ₂ O ₄	Intratracheal	Rat (38)	0/38 local tumour	Steffee & Baetjer (1965)
Mixed chromium dust	Intratracheal	Rabbit (10)	0/10 local tumour	Steffee & Baetjer (1965)
Mixed chromium dust	Intrapleural	Mouse (55)	As controls	Baetjer <i>et al.</i> (1959b)
Residue dust	Intratracheal	Guinea-pig (19)	0/19 vs 0/18	Steffee & Baetjer (1965)
Residue dust	Intratracheal	Rabbit (7)	0/7 local tumour	Steffee & Baetjer (1965)
Roasted chromite ore	Intrapleural	Rat (25)	Bronchial carcinoma: 2/24	Hueper (1958)
Roasted chromite ore	Intrapleural	Rat (35)	3/35 vs 0/35	Payne (1960b)
Roasted chromite ore	Intramuscular	Mouse (52)	0/52 local tumour	Payne (1960b)
Roasted chromite ore	Intramuscular	Rat (31)	3/31 vs 0/15	Hueper (1958)
Roasted chromite residue	Intrapleural	Rat (32)	5/32 vs 0/34	Hueper (1961)
Roasted chromite residue	Intramuscular	Rat (34)	1/34 vs 0/32	Hueper (1961)
Chromate process residue	Intrabronchial	Rat (100)	1/93 vs 0/24	Laskin <i>et al.</i> (1970)

Table 22 (contd)

Compound	Route	Species (No. at start)	Tumour incidence ^a	Reference
Bichromate produc- tion residues (all with < 5% Cr[VI])	Intrabronchial			Levy & Venitt (1986); Levy <i>et al.</i> (1986)
Bolton high lime residue		Rat (100)	0/100	
Alumina precipi- tation residue		Rat (100)	0/100	
Slurry tank resi- due		Rat (100)	0/100	
Vanadium filter residue		Rat (100)	0/100	
Slurry disposal residue tank		Rat (100)	0/100	
Bichromate produc- tion residues with lime				
High lime resi- due (TSS 643D)	Intrabronchial	Rat (99)	Bronchial carcinoma: 1/99 (NS)	Levy <i>et al.</i> (1986)
Kiln frit (CTSS 643B) + 2% limestone	Intrabronchial	Rat (100)	2/100 (NS)	Levy <i>et al.</i> (1986)
Recycled residue (CTSS 643C) + 2% limestone	Intrabronchial	Rat (100)	0/100	Levy <i>et al.</i> (1986)
Pyrolysed Cr[VI]/ Cr[III] 3:2 oxide	Inhalation	Rat (20)	Lung adenoma: 1/20 vs 0/40	Glaser <i>et al.</i> (1986)
Chromium[IV] dioxide	Inhalation	Rat		
Unstabilized (0.5 mg/m ³)		(240)	0/240 vs 0/240	Lee <i>et al.</i> (1988)
Stabilized (0.5 and 25 mg/m ³)		(480)	2/210 adenomas 6/108 keratin cysts 2/108 cystic keratin squamous lesions	

^aNS, not significant

^b*p*-Value calculated by comparing the incidence of bronchial carcinomas in each test group with that in a reference group comprising the two negative control groups and all the groups receiving chromium-containing materials

^cNo. of tumour-bearing animals

3.2 Other relevant data in experimental systems

(a) *Absorption, distribution, excretion and metabolism*

The metabolism of chromium has been reviewed (Aitio *et al.*, 1988; Nieboer & Jusys, 1988; World Health Organization, 1988). De Flora and Wetterhahn (1990) have specifically reviewed the redox chemistry of chromium[VI] with respect to cellular metabolism; a metabolic model has been suggested by Elinder *et al.* (1988).

(i) *Metallic chromium and chromium alloys*

Chromium-cobalt alloys appear to release chromium[VI] after intramuscular implantations in rats (Wapner *et al.*, 1986). Chromium metal powder released chromium[VI] when incubated in aerated phosphate buffer, Ringer's solution, phosphate buffer with added bicarbonate and Locke's physiological buffer (Grogan, 1957).

(ii) *Chromium[III] compounds*

In contrast to chromium[VI] compounds, less than 1% of chromium[III] is absorbed from the gastrointestinal tract of animals (Mertz, 1969).

Four hours after intratracheal instillation of chromic chloride in rabbits, 85% of the chromium remained in the lungs and 8% was found in the urine; after uptake, chromium was confined mainly to plasma, and the peak concentration was reached after 20 min (Wiegand *et al.*, 1984a).

After exposure of rats by inhalation to chromic chloride particles (mass median aerodynamic diameter (MMAD), 1.8 and 1.5 μm ; 19 and 27% less than 1 μm ; 8-10.7 mg chromium/ m^3), only one clearance phase was demonstrated, with a half-time of about 160 h (Suzuki *et al.*, 1984). As with chromium[VI] compounds, the highest organ concentrations in both rats and rabbits were found in the kidney and liver after exposure to chromic chloride by the pulmonary route, although the concentrations found were lower than those after a corresponding exposure to chromium[VI] (Suzuki *et al.*, 1984; Wiegand *et al.*, 1984a).

Chromium (especially trivalent chromium) strongly accumulated in the interstitial tissues of the gonads of male mice, but not in seminiferous epithelium (Danielsson *et al.*, 1984).

Little chromium[III] is taken up by cells (Aaseth *et al.*, 1982; Nieboer & Jusys, 1988), but more of some organic chromium[III] complexes may be taken up (Yamamoto *et al.*, 1981; Norseth *et al.*, 1982).

After parenteral administration of chromium[III] to rats (as with chromium[VI]), chromium is excreted predominantly in the urine (National Research Council, 1974; Langård, 1980, 1982). Less than 2% of an intravenous dose of chromic chloride was found in the faeces of rats 8 h after injection (Hopkins, 1965). In a

subsequent study, seven days after intraperitoneal injection of chromic chloride to mice, the cumulated amounts excreted in faeces and urine were about equal (Bryson & Goodall, 1983).

Studies on the mechanism of excretion of chromium[III] by the kidneys indicate that glomerular filtration is the major mechanism (Donaldson *et al.*, 1986).

As with chromium[VI], biliary excretion of chromic chloride has been demonstrated in rats (Cikrt & Bencko, 1979; Norseth *et al.*, 1982); less than 1% of an intravenously injected dose of chromic chloride was excreted in 5 h (Norseth *et al.*, 1982).

The elimination curve for chromium, as measured by whole-body determination, has an exponential form. In rats, three different components of the curve have been identified, with half-times of 0.5, 5.9 and 83.4 days after intravenous injection of chromic chloride at 1 µg/kg bw Cr (Mertz *et al.*, 1965).

In contrast to results with hexavalent chromium, a single intraperitoneal injection of chromic chloride to mice resulted in 45% retention of chromium three weeks after the injection (Bryson & Goodall, 1983).

In mice administered sodium dichromate, chromium was shown to cross the placenta throughout gestation; transfer was more effective than with chromic chloride, which was not detectably transferred during early gestation, although placental transfer of chromium[III] did occur during late gestation (Danielsson *et al.*, 1982).

A total of 25-30% of chromium administered as chromic chloride to pregnant rats on days 17-20 of gestation was transferred to the placental-fetal unit (Wallach & Verch, 1984). Groups of ICR mice were given a single intraperitoneal injection of [⁵¹Cr]chromic chloride on day 8 of gestation and were sacrificed 4, 8 and 12 h after injection. The radioactivity in the fetus increased with time since injection, whereas maternal blood levels decreased (Iijima *et al.*, 1983a).

(iii) Chromium[VI] compounds

Gastrointestinal absorption of chromates has been reported. In a review, 3-6% of an administered dose was reported to appear in the urine of rats; this may be an underestimate of the absorption from the gastrointestinal tract, which also takes part in chromium excretion (Mertz, 1969). The absorption of chromates depends on the degree of reduction of chromium[VI] to chromium[III], which is poorly absorbed from the gastrointestinal tract (Donaldson & Barreras, 1966; De Flora *et al.*, 1987a).

Following intratracheal administration of sodium chromate solution to rabbits, about 45% (as Cr) remained in the lungs 4 h after instillation; 15% was excreted in urine. The highest concentration of chromium[VI] was reached in red cells after about 3 h, and the corresponding plasma concentration at that time was about one-third of that in red cells (Wiegand *et al.*, 1984a). Absorption from the lungs may be decreased by extracellular reduction of the hexavalent form (Suzuki, 1988).

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Zinc chromate was absorbed in rats exposed to known atmospheric concentrations (6.3-10.7 mg/m³, equivalent to 1.3-2.2 mg/m³ Cr) in an inhalation chamber: a five-fold increase in the blood chromium level was observed after 100 min of exposure by inhalation, and this level increased at a similar rate during the next 150 min (Langård *et al.*, 1978).

Suzuki *et al.* (1984) exposed rats by inhalation to potassium dichromate particles (MMAD, 1.6-2.0 µm: 12-25% of particles < 1 µm; determined by multistage impactor (Andersen Sampler) and controlled by electron microscopy). A two-phase clearance pattern for chromium was demonstrated, the smaller particles having half-times of 30 h and 700 h; for larger particles, a single phase with a half-time of 160 h was demonstrated. [The Working Group noted that no statistical evaluation of the differences is given in the paper.] The authors stated that there might also be an undetected rapid component for the larger particles and noted that reduction of the hexavalent form may explain the two-phase clearance from the respiratory tract after exposure to chromium[VI]. This reduction was demonstrated by Suzuki (1988).

Sodium chromate (69 µg Cr), zinc chromate (66 µg Cr) and lead chromate (38 µg Cr), all at 20 µl, were injected intratracheally into Wistar rats; 30 min later, 36, 25 and 81% of the doses, respectively, were still present in the lungs. From 30 min and up to six days, lung clearance followed first-order kinetics, with half-times of 2.4 days for sodium chromate, 1.9 days for zinc chromate and 1.8 days for lead chromate. Limited amounts of chromium were found in blood and organs after exposure to lead chromate; the concentrations found were similar with sodium and zinc chromates. At ten days, 20% of the dose of sodium and zinc chromates had been excreted in the urine; negligible amounts of lead chromate were found. After exposure to lead chromate, about 80% of the chromium was excreted in faeces during the same interval (Bragt & van Dura, 1983).

Percutaneous absorption of labelled sodium chromate occurred in guinea-pigs (Wahlberg & Skog, 1963): a maximum of 4% of the dose applied on the skin disappeared within 5 h, and labelled chromium was detected in a number of organs.

Following administration of chromium[VI], most of the chromium found in the blood is bound to red blood cells (Mutti *et al.*, 1979; Suzuki *et al.*, 1984; Wiegand *et al.*, 1984a). After exposure of rats by inhalation to potassium dichromate or of rabbits by inhalation to sodium dichromate, the highest concentrations were found in the kidney and liver (Suzuki *et al.*, 1984; Wiegand *et al.*, 1984a). The spleen also contained high concentrations of chromium after subcutaneous administration of potassium dichromate to rats (Mutti *et al.*, 1979). The organ concentrations after exposure to chromium[VI] were always much higher than after a corresponding exposure to chromium[III] (Suzuki *et al.*, 1984; Wiegand *et al.*, 1984a).

After parenteral administration of chromium[VI] to rats, chromium was excreted predominantly in the urine (National Research Council, 1974; Langård, 1980, 1982). Seven days after intraperitoneal injection of potassium chromate to mice, urinary excretion was twice as high as faecal excretion; following administration of chromium[III], faecal excretion was three times as high as urinary excretion (Bryson & Goodall, 1983).

Subcutaneous injections of 3 mg/kg bw potassium dichromate were given to rats every other day for eight weeks. Urinary elimination of chromium increased steadily during the experiment and was correlated with the concentration of chromium in the renal cortex (Franchini *et al.*, 1978).

Elimination of chromium from the blood of rats exposed by inhalation to zinc chromate was slow: the blood chromium level fell by less than 50% during the first three days after exposure; and after 18 and 37 days 20% and 9% of the initial concentration, respectively, remained. Excretion occurred mainly *via* the urine (Langård *et al.*, 1978).

Biliary excretion of chromium following administration of sodium dichromate has been demonstrated in rats (Cikrt & Bencko, 1979; Norseth *et al.*, 1982); 6-8% of an intravenous dose of sodium dichromate was excreted in 5 h (Norseth *et al.*, 1982).

Three weeks after a single intraperitoneal injection of potassium dichromate to mice, 7.5% chromium was retained. After repeated weekly intraperitoneal injections of potassium dichromate, about 3% of chromium was retained eight weeks after the first injection. In both cases, this level is about one-sixth of that observed after administration of chromium[III] (Bryson & Goodall, 1983).

Chromium[VI] (tested as sodium dichromate and as an unspecified chromate *in vitro*) was transported effectively through mammalian cell membranes by the carboxylate, sulfate and phosphate carrier systems; the kinetics of uptake also involve intracellular reduction to the trivalent form (Sanderson, 1976; Wetterhahn-Jennette, 1981; Aaseth *et al.*, 1982; Alexander *et al.*, 1982). Chromium[VI] (tested as sodium dichromate) was rapidly reduced to chromium[III] after cellular uptake, but such reduction may also take place outside the cell, with decreased uptake as a result (De Flora *et al.*, 1987a; Suzuki, 1988). Glutathione seems to be the most important factor for intracellular reduction of chromium[VI], but ascorbic acid, microsomes in the presence of NAD/NADH microsomal cytochrome P450, mitochondria and proteins such as haemoglobin and glutathione reductase in red blood cells may also be active in the reduction process (Connett & Wetterhahn, 1983; Ryberg & Alexander, 1984; Wiegand *et al.*, 1984b; Connett & Wetterhahn, 1985; De Flora & Wetterhahn, 1990). Once absorbed and retained in biological tissue, chromium compounds occur in the trivalent form (Mertz, 1969). Initial binding may involve the pentavalent form (Rossi & Wetterhahn, 1989). When the reducing

capacity of liver cells is decreased, the hexavalent form may be found in bile (Norseth *et al.*, 1982).

After treatment of rats with sodium dichromate at 20 mg/kg bw intraperitoneally (134 μ mol/kg bw Cr), more of the chromium associated with chromatin was bound to DNA than was the case after chromic chloride treatment (Cupo & Wetterhahn, 1985a).

The intracellular reduction of hexavalent chromium implies the generation of short-lived species of pentavalent and tetravalent chromium with affinities that differ from that of the trivalent form (Connett & Wetterhahn, 1983). The pentavalent form is stabilized by increased amounts of glutathione (Kitagawa *et al.*, 1988). The reduction process thus serves as a detoxification process even intracellularly, when it takes place at a distance from the target site for toxic or genotoxic effect; it serves to activate if it takes place near the cell nucleus, presumably of target organs (De Flora & Wetterhahn, 1990). It has been suggested that phagocytosis may be important for the uptake of hexavalent compounds — in particular soluble forms — as it would allow the slow intracellular release of chromate ions over a long time (Norseth, 1986).

(b) Toxic effects

As a general rule, chromium[VI] is much more toxic than chromium[III] when administered to animals, and very marked differences in the cytotoxicity of compounds of the two oxidation states have been observed *in vitro*. Effects on the kidney and the respiratory organs are the most important (for reviews, see Nieboer & Jusys, 1988; World Health Organization, 1988).

The mean intravenous lethal dose in mice is 85 mg/kg bw chromic sulfate, 400-800 mg/kg bw chromic chloride and 2290 mg/kg bw chromic acetate (National Research Council, 1974). The LD₅₀ in rats for potassium dichromate administered by stomach tube was reported to be 177 mg/kg for males and 149 mg/kg for females (World Health Organization, 1988).

(i) Chromium[III] compounds

Morphological changes in rabbit alveolar macrophages occurred after exposure by inhalation to chromic nitrate (0.6 mg/m³ Cr) for four to six weeks. Fewer macrophages were obtained by lavage than with chromium[VI], but only chromium[III] caused functional changes in macrophages, measured by increased metabolic activity and reduced phagocytotic activity. The authors speculated that these effects may be due to the release of chromium[III] ions from phagocytized particles, with subsequent binding to macromolecules in the cell. Such particles were not seen after exposure to chromium[VI] (Johansson *et al.*, 1986).

Chromium[III] has been found in ribonucleic acids from all sources examined. It is possible that chromium helps stabilize the structure of RNA (Wacker & Vallee,

1959). Chromium bound to only a limited extent to chromatin and DNA from the liver and kidney of rats treated intraperitoneally with chromic chloride at 80 mg/kg bw (290 $\mu\text{mol/kg bw Cr}$), as indicated in a study by Tsapakos *et al.* (1983a); DNA damage, as measured by alkaline elution, was not demonstrable in kidney after injection of chromium[III]. The binding of chromic nitrate to denatured or native DNA was limited and relatively unaffected by the presence of microsomes and NADPH (Tsapakos & Wetterhahn, 1983).

Chromic chloride was 100 times less effective than chromium[VI] in inhibiting DNA synthesis (Levis *et al.*, 1978a). A large difference in cytotoxic activity between chromium[VI] and chromium[III] was also noted when the effects of 11 water-soluble chromium compounds on BHK cells were compared: of the chromium[III] compounds, only chromic nitrate appeared to be cytotoxic, but it was contaminated with chromium[VI] at about 0.2% (Levis & Majone, 1979).

Chromic chloride inhibited the uptake of ribo- and deoxyribonucleosides by BHK cells (Levis *et al.*, 1978a). In contrast to chromium[VI], chromic chloride inhibited the plasma membrane Mg^{2+} -ATPase activity of BHK cells only when it was present in the incubation medium and not when cells were pretreated with it (Luciani *et al.*, 1979).

Chromic oxide particles are taken up by cells by phagocytosis; chromium[III] may thus reach its target sites even if it is not derived from intracellular chromate ion. An inhibitory effect on cell cycle progression in Chinese hamster cells was demonstrated after exposure to crystalline chromic oxide (particle size, 91% < 1 μm ; purity, 99.8%) at concentrations ranging from 50 to 200 $\mu\text{g/ml}$ (Elias *et al.*, 1986). Chromic chloride does, however, stimulate RNA synthesis both *in vitro* and *in vivo* in mouse liver and in regenerating rat liver (Okada *et al.*, 1981, 1983, 1984).

(ii) Chromium[VI] compounds

Renal lesions in animals are confined to the proximal convoluted tubules (for review, see National Research Council, 1974; Aitio *et al.*, 1988; World Health Organization, 1988). In rats exposed to a single subcutaneous dose of 15 mg/kg bw potassium dichromate, increases in urinary β -glucuronidase, lysozyme, glucose and protein as well as morphological changes in renal tubules were observed, although the glomerular filtration rate was unchanged (Franchini *et al.*, 1978).

Ngaha (1981) demonstrated that urinary volume was increased with increased amounts of acid and alkaline phosphatases in the urine in rats after subcutaneous injection of potassium dichromate at 25 mg/kg. The concentrations of the phosphatases and of lactate dehydrogenase in kidney tissue decreased. No significant change in the levels of these enzymes in liver tissue was demonstrated.

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Morphological changes occurred in rabbit alveolar macrophages after exposure by inhalation to sodium chromate ($0.9 \text{ mg/m}^3 \text{ Cr}$) for four to six weeks. Significantly more macrophages were present in the lavage fluid from the chromium[VI]-exposed animals than in those exposed to chromium[III], but functional changes in macrophages were observed after exposure to chromium[III] and not after exposure to chromium[VI] (Johansson *et al.*, 1986). Activation of phagocytosis was demonstrated in rat alveolar macrophages after exposure to $25\text{-}50 \text{ }\mu\text{g/m}^3$ sodium dichromate by inhalation for 28 days; exposure to $200 \text{ }\mu\text{g/m}^3$ for the same interval inhibited phagocytotic function. Lung clearance of inhaled [^{59}Fe] iron oxide was significantly decreased after exposure to the high dose of sodium dichromate. The antibody response to sheep red blood cells and the mitogen-stimulated T-lymphocyte response were stimulated at the low doses but inhibited at the high dose (Glaser *et al.*, 1985).

Exposure of cats by inhalation to $11\text{-}23 \text{ mg/m}^3$ chromium[VI] as dichromate for 2-3 h/day during five days caused bronchitis and pneumonia. In rabbits exposed similarly, no effect was observed. Mixed dusts containing chromates (7 mg/m^3 as chromium trioxide) were fatal to mice when inhaled for 37 h over ten days; whereas no marked effect was noted in rabbits or guinea-pigs that inhaled 5 mg/m^3 (as chromium trioxide) for 4 h/day on five days/week for one year (National Research Council, 1974). Increased subepithelial connective tissue and flattened epithelium in the large bronchi were observed in mice exposed to chromate (Nettesheim *et al.*, 1971).

In chronically treated cell cultures, chromium[VI] was much more active than chromium[III] in reducing cell growth and survival, independently of the particular compound used (Bianchi *et al.*, 1980). Chromium bound to chromatin and DNA from liver and kidney of rats treated intraperitoneally with sodium dichromate ($140 \text{ }\mu\text{mol}$ [7.2 mg]/kg as Cr) (Tsapakos *et al.*, 1983a). Binding of chromium to nucleic acids *in vitro* depends on the reduction of the chromium[VI] to chromium[III]. In contrast to chromium[III], binding to denaturated or native DNA was demonstrated with potassium dichromate only in the presence of the complete microsomal reducing system (Tsapakos & Wetterhahn, 1983).

Potassium dichromate induced a rapid blockage of DNA replication in Syrian hamster fibroblasts (BHK line), whereas RNA and protein synthesis were inhibited secondarily (Levis *et al.*, 1978b). It also reduced the colony-forming ability of BHK cells at $10^{-7}\text{-}10^{-4}\text{M}$. It facilitated the uptake of ribo- and deoxyribonucleosides in BHK cells (Levis *et al.*, 1978a). The effect of potassium dichromate on the nucleoside pool in BHK cells could not be explained solely by changes in transport (Bianchi *et al.*, 1979). Plasma membrane Mg^{2+} -ATPase activity of BHK cells was inhibited when the cells were pretreated with potassium dichromate, even when chromate was absent from the assay medium (Luciani *et al.*, 1979). Mitochondrial

respiration was inhibited by about 50% by the addition of 25 μ M [1.3 mg] sodium chromate in rat liver (Ryberg & Alexander, 1984).

(c) *Effects on reproduction and prenatal toxicity*

(i) *Chromium[III] compounds*

Treatment of sea-urchin sperm with potassium chromic sulfate or chromic nitrate (5×10^{-5} - 5×10^{-4} M [2.6-26 mg]) before fertilization failed to induce larval malformation (Pagano *et al.*, 1983).

In cultured mouse embryos, chromium nitrate (0.02-2 μ g/ml Cr) caused less impairment of blastocyst formation and inhibition of hatching from the zona pellucida to the formation of the inner cell mass than the chromium[VI] salts tested (Jacquet & Draye, 1982).

In contrast to chromium[VI], chromic chloride showed no overt cytotoxicity in chick limb bud mesenchymal cells *in vitro* (Danielsson *et al.*, 1982).

Groups of 30 pregnant ICR mice were given a single intraperitoneal injection of [51 Cr]chromic chloride (19.5 mg/kg bw Cr) on day 8 of gestation and were sacrificed at intervals of 4-192 h after injection. More pyknotic cells were observed in the neural plate of experimental embryos than controls [percentages not given], especially by 8 h after injection (Iijima *et al.*, 1983a).

A dose-dependent increase in the frequency of rib fusion in fetuses (6-16%, depending on dose) and exencephaly and anencephaly were seen occasionally at higher dose levels following intraperitoneal injection of 9.8-24.4 mg/kg bw chromic chloride to mice on day 8 of gestation. Maternal effects were not described (Matsumoto *et al.*, 1976).

(ii) *Chromium[VI] compounds*

Treatment of sea-urchin sperm with sodium chromate before fertilization resulted in a number of abnormal larvae, depending on length of exposure and concentration. Sea-urchin embryos reared in the presence of chromate at 5×10^{-5} - 5×10^{-4} M had retarded differentiation of the gut and skeleton (Pagano *et al.*, 1983).

Cultured mouse embryos at the two-cell stage were incubated in Brinster's medium with potassium chromate or calcium chromate (0.02-2 μ g/ml Cr). Blastocyst formation was damaged, and hatching of the blastocyst from the zona pellucida to the formation of the inner cell mass was inhibited (Jacquet & Draye, 1982).

As reported in an abstract, male mice were administered 3×10^{-3} M [882 mg] potassium bichromate by either intratesticular or intraperitoneal injection, then mated weekly. A decrease in the number of sperm was seen after three weeks of treatment, and abnormalities in shape reached about 50% of the total sperm after four weeks of treatment. Decreases in the number of implantation sites, in litter size and in fetal body weight were observed. No conspicuous malformation of fetuses

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was detected. None of the females became pregnant after three weeks of treatment of males (Yasuda, 1980).

Sodium chromate inhibited chondrogenesis in chick limb bud mesenchymal cells *in vitro* at concentrations of about 0.1 $\mu\text{g/ml}$ Cr (Danielsson *et al.*, 1982).

Chromium trioxide dissolved in saline was injected into the air sacs of embryonated chicken eggs at doses of 0.002-0.05 mg/egg on days 0-4 of incubation. Control eggs were injected with a comparable volume of saline. All embryos were examined on day 8, and malformations, such as short and twisted limbs, microphthalmia, exencephaly, short and twisted neck, everted viscera, oedema and reduced body size, were observed in treated eggs. Most embryos showed unilateral or bilateral limb defects (Gilani & Marano, 1979).

Chromium trioxide was administered intravenously at doses of 5, 7.5, 10 or 15 mg/kg bw to groups of ten pregnant golden hamsters early on day 8 of gestation. Fetuses were collected on gestation days 12, 14 and 15 and were examined for frequency and types of malformations. In the different dose groups, 6-40% of the fetuses were resorbed and 1-100% of fetuses had growth retardation; 2% of control fetuses were resorbed. Maternal toxicity (mortality, decreased weight gain, kidney tubular necrosis) was seen in treated animals. Cleft palate occurred in 34-85% of exposed fetuses (2% in controls) and defects in skeletal ossification in up to 96% (Gale, 1978). On comparing five strains of hamsters (ten animals per group, exposure to 8 mg/kg bw on day 8), different susceptibilities were observed: three strains were very susceptible to the embryotoxic effects, while the others were more resistant. In the more susceptible strains, the percentage of resorption sites was 13-28%, whereas in the less susceptible strains it was 7-11%. External abnormalities observed were cleft palate (0-30%) and hydrocephalus. Maternal toxicity (decreased weight gain) was seen in all groups. The time of administration of the chromium trioxide was important: cleft palate was induced only when chromium was administered on day 7, 8 or 9 of gestation and not when it was given on day 10 or 11 (Gale & Bunch, 1979; Gale, 1982).

(d) *Genetic and related effects*

The activity of chromium and chromium compounds in tests for genetic and related effects was evaluated in previous *IARC Monographs* (1980a, 1982, 1987a,b). Moreover, a number of reviews on this subject are available in the literature (e.g., Heck & Costa, 1982a,b; Léonard & Lauwerys, 1980; Petrilli & De Flora, 1980; Paschin & Kozachenko, 1981; Levis & Bianchi, 1982; Petrilli & De Flora, 1982; Baker, 1984; Bianchi & Levis, 1984; Hansen & Stern, 1984; Bianchi & Levis, 1985; Petrilli *et al.*, 1986a,b; Sunderman, 1986; Venitt, 1986; Bianchi & Levis, 1987, 1988; Nieboer & Shaw, 1988; World Health Organization, 1988; De Flora *et al.*, 1990).

Over 600 reports have been published on 32 chromium compounds of various oxidation states and solubilities, and the data base covers 125 experimental systems with different endpoints and/or targets. The studies described below are summarized in Appendix 1 to this volume.

(i) *Metallic chromium*

Metallic chromium was assayed for the ability to induce cell transformation (anchorage-independent growth) in Syrian hamster BHK fibroblasts. Although chromium particles were phagocytized by cells, no significant increase in the number of cell foci growing in soft agar was observed (Hansen & Stern, 1985). [See General Remarks, p. 44, for concerns about this assay.]

As reported in an abstract, male Sprague-Dawley rats were exposed to chromium fumes generated from powders of chromium metal by a plasma flame sprayer at concentrations of 1.84 ± 0.55 mg/m³ or 0.55 ± 0.07 mg/m³ fume for 5 h/day on five days a week for one week or two months. Significant increases in the frequencies of sister chromatid exchange and of chromosomal aberrations were observed in peripheral blood lymphocytes, whereas chromosomal aberration frequencies in bone-marrow cells were unchanged (Koshi *et al.*, 1987). [The Working Group noted that some oxidation of metallic chromium may have occurred during generation of the fumes.]

(ii) *Chromium[III] compounds*

Twelve chromium[III] compounds of various water solubilities were assayed in a number of short-term tests, often at the same time as chromium compounds of other oxidation states. They included: (a) highly soluble compounds, such as chromic chloride, chromic acetate, chromic nitrate, chromic sulfate and chromic potassium sulfate; (b) sparingly soluble products, such as basic chromic sulfate or neo-chromium, chromium alum and chromic phosphate; and (c) almost insoluble compounds, such as chromic hydroxide, chromic oxide, chromite ore and cupric chromite. In addition, several reports dealt with the activity of chromium[III] tannins and of chromium[III] compounds bound to organic ligands, as described below. In evaluating the results, summarized in Appendix 1, it should be noted that some of the positive results, obtained with both pure laboratory compounds and industrial products, might be due to contamination by traces of chromium[VI] (indicated as [+] in Appendix 1); therefore, reported positive results with chromium[III] compounds should be interpreted with caution, particularly for those studies in which the purity of test compounds was not checked.

In several studies, the activity of chromic chloride in acellular (i.e., purified nucleic acids) or subcellular (i.e., cell nuclei) systems was investigated. Depurination of calf thymus DNA did not occur, as shown by the unchanged release of adenine detectable by thin-layer chromatography. In addition, it did not induce

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mutation of single-stranded ϕ X 174 *am3* DNA, transfected into *Escherichia coli* spheroplasts and then tested for reversion in a progeny phage assay (Schaaper *et al.*, 1987). As reported previously, chromium[VI] trioxide was also inactive in this system; chromic chloride, however, induced *lacZ* α forward mutation in double-stranded M13mp2 DNA, transfected into JM101 *E. coli* (Snow & Xu, 1989). Moreover, chromic chloride suppressed the infectivity of tobacco mosaic virus RNA, probably by nonenzymic cleavage of internucleotide phosphodiester bonds (Huff *et al.*, 1964). Assessments of viscosity, ultraviolet absorption spectra and thermal denaturation of purified DNA and RNA showed that, at variance with chromium[VI] which (as an oxidizing agent) breaks the polynucleotide chain (see potassium dichromate), chromium[III] is responsible for physicochemical alterations of nucleic acids by interacting with the phosphate groups and nitrogen bases (Tamino & Peretta, 1980; Tamino *et al.*, 1981). As evaluated by nucleotide incorporation into calf thymus DNA in the presence of *E. coli* DNA polymerase, chromic chloride inhibited DNA synthesis more potently than chromium[VI] (potassium dichromate); however, at levels below the inhibitory concentration, it enhanced nucleotide incorporation (Nishio & Uyeki, 1985). Like chromium[VI] (potassium dichromate), chromic chloride increased misincorporation of nucleotide bases into daughter DNA strands synthesized from a synthetic polynucleotide template, poly[d(A-T)], in the presence of avian myeloblastosis virus or *E. coli* DNA polymerases (Sirover & Loeb, 1976; Tkeshelashvili *et al.*, 1980). The misincorporated bases were present as single-base substitutions (Tkeshelashvili *et al.*, 1980). In contrast to chromium[VI] salts (potassium chromate and potassium dichromate), chromic chloride favoured cross-links between *E. coli* DNA and bovine serum albumin, as assessed by checking ³H-DNA-bovine serum albumin binding in a filtration assay (Fornace *et al.*, 1981). The same chromium[III] compound produced DNA fragmentation (alkaline elution technique), as determined by single-strand breaks and cross-links in isolated calf thymus nuclei (Beyersmann & Köster, 1987) and in purified DNA from V79 cells (Bianchi *et al.*, 1983). DNA-protein cross-links were also detected by exposing nuclei of mouse leukaemia L1210 cells to chromic chloride; chromium[VI] (potassium chromate) was inactive (Fornace *et al.*, 1981).

Most studies in which the activity of chromium[III] compounds was evaluated in prokaryotes yielded negative results. Chromic chloride did not induce λ prophage in *E. coli* WP2_s(λ) (Rossman *et al.*, 1984) after overnight incubation at concentrations near the growth inhibitory concentration of the compound. No SOS response was induced in *E. coli* GC2375, UA4202 or PQ30 by chromic chloride, chromic nitrate or chromic acetate (Llagostera *et al.*, 1986), or in strain PQ37 by chromic potassium sulfate (De Flora *et al.*, 1985a) or chromic chloride (Olivier & Marzin, 1987). Chromic nitrate, chromic chloride and chromic potassium sulfate

were confirmed to be inactive in strain PQ37, whereas chromic acetate produced a low but significant increase in SOS-inducing activity (Venier *et al.*, 1989).

In differential killing assays with *E. coli*, chromic chloride was equally toxic in the wild strain AB1157 and in the repair-deficient strains AB1886 (*uvrA*⁻), GW801 (*recA*56⁻), GW802 (*recA*56⁻*uvrA*6⁻), PAM AA34 (*recA*56⁻*lexA*2⁻) and PAM5717 (*lexA*2⁻) (Warren *et al.*, 1981).

Chromic chloride, chromic phosphate and chromic oxide (spotted in powder form) were equally toxic in *E. coli* WP2 (wild strain) and in the repair-deficient strains WP2 *uvrA* (*uvrA*⁻), CM571 (*recA*⁻) and WP100 (*uvrA*⁻ *recA*⁻), as assessed by the streak method on agar and, in the case of chromic phosphate, by means of a test-tube assay (Yagi & Nishioka, 1977).

Chromic chloride and chromic acetate were equally toxic to WP2 and to the repair-deficient strains WP67 (*uvrA*⁻*polA*⁻) and CM871 (*uvrA*⁻*recA*⁻*lexA*⁻) when assayed in the treat-and-plate test, but these compounds, chromic nitrate and chromic potassium sulfate were more toxic in the repair-deficient strains when assayed by a liquid micromethod (De Flora *et al.*, 1984a). Four conditions were required to elicit this unusual positivity of chromium[III] in this system: (a) performance of the test in a liquid medium, (b) long contact between chromium[III] and bacteria (at least 6-8 h), (c) a physiological pH (7.0-7.4) and (d) the presence of high, subtoxic concentrations (0.2-0.3 M) of phosphate (De Flora *et al.*, 1990). Chromic chloride, chromic sulfate and chromic potassium sulfate did not induce differential killing of *S. typhimurium* TA1978 (wild strain) or TA1538 (*rec*⁻) (Gentile *et al.*, 1981). In the *rec* assay in *Bacillus subtilis* H17 (wild strain) and M45 (*rec*⁻), negative results were obtained with chromic chloride (Nishioka, 1975; Nakamuro *et al.*, 1978; Matsui, 1980; Gentile *et al.*, 1981), chromic sulfate and chromic potassium sulfate (Kada *et al.*, 1980; Kanematsu *et al.*, 1980; Gentile *et al.*, 1981). Positive results were obtained in this system, using the spot test procedure, with chromic acetate and chromic nitrate. Chromic acetate also gave positive results in the *arg*⁻ → *arg*⁺ reversion test in *E. coli* Hs30R (Nakamuro *et al.*, 1978).

No reversion of *trp*⁻ → *trp*⁺ was produced in *E. coli* by chromic chloride or chromic acetate (strains WP2 and WP2*uvrA*) (Petrilli & De Flora, 1982) or by chromic sulfate (strain DG1153) (Arlauskas *et al.*, 1985). In a *lacI*⁺/*lacI*⁻ forward mutation assay in *E. coli* KMBL3835, chromic chloride yielded unclear results (Zakour & Glickman, 1984).

In more than 30 reports (see Appendix 2), highly soluble or sparingly soluble chromium[III] compounds were inactive in the *his*⁻ → *his*⁺ reversion test in several strains of *Salmonella typhimurium* (TA1535, TA1537, TA1538, TA92, TA94, TA97, TA98, TA100 and TA102) in the absence of exogenous metabolic systems (Tamaro *et al.*, 1975; Petrilli & De Flora, 1977, 1978a; De Flora, 1981a; Tso & Fung, 1981; Venier *et al.*, 1982; Bennicelli *et al.*, 1983; Bianchi *et al.*, 1983; De Flora *et al.*, 1984a,b;

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Arlauskas *et al.*, 1985; Langerwerf *et al.*, 1985; Loprieno *et al.*, 1985; Marzin & Phi, 1985; Petrilli *et al.*, 1985). Chromic chloride, chromic nitrate, chromic potassium sulfate, chromium alum and neochromium were still not mutagenic in the presence of metabolic systems, including post-mitochondrial supernatants of rat liver, lung or muscle, rat muscle mitochondria (with or without ATP), human erythrocyte lysates and oxidized glutathione. Mutagenic effects were produced by all these compounds only in the presence of a strong oxidizing agent, such as potassium permanganate (Petrilli & De Flora, 1978a). The inactivity of chromic sulfate was unaffected by the presence of nitrilotriacetic acid (NTA) (Loprieno *et al.*, 1985). Surprisingly, high amounts of chromic chloride [unspecified source and purity] were reported to be weakly mutagenic to strains TA98 and TA94 in one study (Langerwerf *et al.*, 1985). Other positive results can be ascribed to contamination with traces of chromium[VI], in a chromic nitrate sample (Venier *et al.*, 1982; Bianchi *et al.*, 1983) and in an industrial chromite sample (Petrilli & De Flora, 1978a; De Flora, 1981a; Venier *et al.*, 1982; Bianchi *et al.*, 1983).

Chromic chloride was reported to induce mitotic gene conversion at the *trp5* locus and point reverse mutation at the *ilv* locus in strain D7 of *Saccharomyces cerevisiae*. Such activity, usually detected when the yeast was in the logarithmic growth phase, was very weak, was obtained only with high doses of chromium[III] and occurred only in the presence of 0.1 M phosphate; no activity was seen when 0.05 M Tris-hydrochloric acid was used as the buffer (Galli *et al.*, 1985; Bronzetti *et al.*, 1986).

Chromic potassium sulfate gave weakly positive results in an unscheduled DNA synthesis assay in mature pollen of *Petunia hybrida* (W166K) (Jackson & Linskens, 1982). [The Working Group noted that the effect was very weak and that the existence of a dose-response relationship was not investigated.] Chromic nitrate induced chromosomal aberrations in the root tips of *Vicia faba* (Gläss, 1955).

A study of the cytotoxic effects produced in Syrian hamster BHK monolayers and of mitotic cycle alterations in human epithelial-like heteroploid HEp2 cells produced by chromic chloride, chromic sulfate, chromium alum, neochromium and chromium[VI]-contaminated chromite provided evidence that chromium[III] is far less active than chromium[VI] (Levis & Majone, 1981). Chromic chloride did not induce unscheduled DNA synthesis in mouse kidney A18BcR cells (Raffetto *et al.*, 1977) or human heteroploid EUE cells (Bianchi *et al.*, 1983). It did not inhibit DNA synthesis in Syrian hamster BHK fibroblasts, even when the cells were reversibly permeabilized in hypertonic medium (Bianchi *et al.*, 1984), or in mouse L cells unless they were permeabilized with detergents (Nishio & Uyeki, 1985).

Chromic chloride did not induce DNA fragmentation in mouse leukaemia 1210 cells (Fornace *et al.*, 1981), in Chinese hamster V79 cells (Bianchi *et al.*, 1983) or in human embryo lung IMR-90 fibroblasts (Fornace *et al.*, 1981), as assessed by al-

kaline elution, or in human white blood cells, as assessed by the alkaline unwinding technique (McLean *et al.*, 1982). Similarly, chromic nitrate, even at concentrations up to 25 times those of chromium[VI] compounds needed to damage DNA, did not produce DNA fragmentation (alkaline elution) in chicken embryo hepatocytes (Tsapakos *et al.*, 1983b). In contrast, a sample of cupric chromite induced DNA-protein cross-links in Novikoff ascites hepatoma cells, as evaluated by high-speed centrifugation of detergent-treated cells followed by polyacrylamide gel electrophoresis; chromous chloride was inactive in this test (Wedrychowski *et al.*, 1986a).

Using the *hprt* forward mutation assay, negative results were obtained with chromic sulfate in mouse mammary carcinoma Fm3A cells (8-azaguanine resistance) (Nishimura & Umeda, 1978 [Abstract]), with chromic acetate in Chinese hamster V79/4 cells (8-azaguanine resistance) (Newbold *et al.*, 1979) and in CHO cells (6-thioguanine resistance) (Bianchi *et al.*, 1983). In V79 cells, a sample of chromic oxide, uncontaminated with chromium[VI] was phagocytized, as shown by electron microscopic detection of intracytoplasmic vacuoles containing crystalline chromic oxide particles, after an 18-h exposure of cells; it also induced 6-thioguanine resistance (Elias *et al.*, 1986).

Mostly negative results have been reported with regard to the induction of sister chromatid exchange by chromium[III] compounds in various types of cultured mammalian cells (Table 23). Both positive and negative results have been reported in the literature concerning the ability of these compounds to induce chromosomal aberrations in mammalian cells (Table 24). In parallel assays, aberrations were induced more frequently than sister chromatid exchange by chromium[III] compounds, but much higher concentrations of chromium[III] than chromium[VI] were generally needed to induce chromosomal aberrations, due perhaps to an indirect effect of high doses, such as the release of lysosomal nucleases (Levis & Majone, 1981). The decreased frequency of chromium[III]-induced chromosomal aberrations in the presence of superoxide dismutase, copper (salicylate), copper (tyrosine), catalase and mannitol suggests the involvement of active oxygen species (Friedman *et al.*, 1987). The occasional finding of both sister chromatid exchange and chromosomal aberrations in CHO cells was ascribed by the authors to contamination of their chromium[III] samples with traces of chromium[VI] (Levis & Majone, 1979; Bianchi *et al.*, 1980; Venier *et al.*, 1982).

Chromic chloride inhibited spindle formation in human skin fibroblasts, but only at the highest concentration tested (100 μ M), which was several orders of magnitude higher than the concentration required for chromium[VI] compounds (sodium chromate and calcium chromate) to produce the same effect (Nijs & Kirsch-Volders, 1986).

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Table 23. Induction of sister chromatid exchange by chromium[III] compounds in cultured mammalian cells

Chromium compound	Cell line	Result and comments	Reference
Chromic acetate	Chinese hamster CHO	-	Levis & Majone (1979)
		-	Bianchi <i>et al.</i> (1980)
	Mouse macrophage P388D ₁	+	Andersen (1983)
	Human peripheral lymphocytes	+	Andersen (1983)
Chromic chloride	Mouse primary lymphocytes (BALB/c)	-	Venier <i>et al.</i> (1982)
		-	Majone <i>et al.</i> (1983)
		-	Bianchi <i>et al.</i> (1983)
		-	Venier <i>et al.</i> (1982)
	Mouse primary lymphocytes (BALB/Mo)	-	Majone <i>et al.</i> (1983)
		-	Bianchi <i>et al.</i> (1983)
		-	Bianchi <i>et al.</i> (1983)
		-	Venier <i>et al.</i> (1982)
	Mouse LSTRA lymphocytes	-	Bianchi <i>et al.</i> (1983)
		-	Bianchi <i>et al.</i> (1983)
		-	Tsuda & Kato (1977)
		-	Macrae <i>et al.</i> (1979)
	Syrian hamster embryo primary	-	Levis & Majone (1979)
		-	Levis & Majone (1981)
		-	Majone & Rensi (1979)
		-	Bianchi <i>et al.</i> (1980)
	Chinese hamster CHO	-	Bianchi <i>et al.</i> (1983)
		-	Venier <i>et al.</i> (1982)
		-	Uyeki & Nishio (1983)
		+ (48-h incubation)	Venier <i>et al.</i> (1985a)
	Chinese hamster lung Don	-	Koshi (1979)
		+	Ohno <i>et al.</i> (1982)
	BHK fibroblasts	-	Bianchi <i>et al.</i> (1984)
	BHK fibroblasts (permeabilized)	-	Bianchi <i>et al.</i> (1984)
	Human peripheral lymphocytes	-	Ogawa <i>et al.</i> (1978)
		-	Stella <i>et al.</i> (1982)
	Chinese hamster V79	+ (300 × dose needed for Cr[VI])	Elias <i>et al.</i> (1983)
Chromic nitrate	Chinese hamster CHO	-	Levis & Majone (1979)
		-	Bianchi <i>et al.</i> (1980)
		-	Venier <i>et al.</i> (1982)

Table 23 (contd)

Chromium compound	Cell line	Result and comments	Reference
Chromic potassium sulfate	Chinese hamster CHO	-	Levis & Majone (1979)
		-	Bianchi <i>et al.</i> (1980)
Chromic sulfate	Chinese hamster CHO	-	Levis & Majone (1981)
		-	Loprieno <i>et al.</i> (1985)
	Chinese hamster lung Don	-	Ohno <i>et al.</i> (1982)
Chromium alum	Chinese hamster CHO	-	Levis & Majone (1981)
		-	Venier <i>et al.</i> (1982)
Neochromium	Chinese hamster CHO	-	Levis & Majone (1981)
Chromic oxide	Mouse macrophage P388D ₁	- (taken up by cells after 48 h)	Andersen (1983)
	Chinese hamster V79	+ (1000 × dose needed for Cr[VI])	Elias <i>et al.</i> (1983)

Chromic chloride (Bianchi *et al.*, 1983; Hansen & Stern, 1985) and chromic oxide (Hansen & Stern, 1985) did not induce anchorage-independent growth in Syrian hamster BHK fibroblasts (see General Remarks, p. 44, for concern about this assay). Chromic chloride was reported to produce morphological transformation of mouse fetal cells (Raffetto *et al.*, 1977), but it did not transform Syrian hamster embryo primary cells nor, in contrast to chromium[VI] (potassium chromate), did it affect the transforming capacity of benzo[*a*]pyrene (Rivedal & Sanner, 1981).

In vivo, intraperitoneal injection of chromic chloride did not induce DNA fragmentation in rat liver or kidney cells (Tsapakos *et al.*, 1983b; Cupo & Wetterhahn, 1985a), as assessed by the alkaline elution technique in the same laboratory from which positive results were reported with chromium[VI] (see sodium dichromate). The number of micronucleated erythrocytes in bone-marrow cells of BALB/c mice was not increased after intraperitoneal injection of 250-500 mg/kg bw chromic nitrate, which contrasts with the positive result recorded with a soluble chromium[VI] compound (potassium dichromate) at ten-fold lower doses (Fabry, 1980).

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Table 24. Induction of chromosomal aberrations by chromium[III] compounds in cultured mammalian cells

Chromium compound	Cell line	Result	Reference
Chromic acetate	Chinese hamster CHO	+	Levis & Majone (1979)
		+	Bianchi <i>et al.</i> (1980)
Chromic chloride	Human peripheral lymphocytes	+	Nakamuro <i>et al.</i> (1978)
	Mouse fetal	+	Raffetto <i>et al.</i> (1977)
	Syrian hamster embryo	-	Tsuda & Kato (1977)
	Chinese hamster CHO	+	Levis & Majone (1979)
		+	Levis & Majone (1981)
		+	Majone & Rensi (1979)
		+	Bianchi <i>et al.</i> (1980)
		+	Venier <i>et al.</i> (1982)
	Human peripheral lymphocytes	-	Nakamuro <i>et al.</i> (1978)
		-	Sarto <i>et al.</i> (1980)
Chromic nitrate		+	Kaneko (1976)
		+	Stella <i>et al.</i> (1982)
	Chinese hamster CHO	-	Levis & Majone (1979)
		-	Bianchi <i>et al.</i> (1980)
		-	Venier <i>et al.</i> (1982)
Chromic potassium sulfate	Human peripheral lymphocytes	-	Nakamuro <i>et al.</i> (1978)
	Chinese hamster CHO	+	Levis & Majone (1979)
Chromic sulfate		+	Bianchi <i>et al.</i> (1980)
	Mouse mammary carcinoma Fm3A	-	Umeda & Nishimura (1979)
	Syrian hamster embryo primary	-	Tsuda & Kato (1977)
	Chinese hamster CHO	+	Levis & Majone (1981)
	Chinese hamster 237-2a	+	Rössner <i>et al.</i> (1981)
Chromium alum	Chinese hamster CHO	+	Levis & Majone (1981)
Neochromium	Chinese hamster CHO	+	Levis & Majone (1981)
Chromic oxide	Chinese hamster CHO	[+]	Levis & Majone (1981)
		[+]	Venier <i>et al.</i> (1982)

The results of these studies with pure and industrial chromium[III] products are summarized in Appendix 1. Data on the genotoxicity of chromium tanning liquors used in the hide and leather industry, most of which are composed of almost insoluble sulfates, are also available. None of 17 tanning liquors, dissolved in water, acids or alkali, reverted *his⁻ S. typhimurium* strains; however, the frequency of sister chromatid exchange was increased by eight (including chromium alum) of 13

tannins tested in Chinese hamster CHO cells. Contamination with chromium[VI] was detected in four of the active compounds (Venier *et al.*, 1982, 1985a).

The marked differences in potency seen in parallel assays with chromium[III] and chromium[VI] compounds have already been commented upon. The positive results sometimes obtained with chromium[III] compounds (46 positive and 141 negative results) can be ascribed to a variety of factors, which emerged from analyses of the literature (Levis *et al.*, 1978b; Levis & Bianchi, 1982). These include unquantified contamination with trace amounts of chromium[VI], nonspecific effects of very high doses, and penetration of chromium[III] by endocytosis following long exposure *in vitro* or under special treatment conditions, such as exposure to detergents or to subtoxic concentrations of phosphate. In addition, a technical artefact may result from interaction of chromium[III] with DNA released from disrupted cells during extraction procedures.

Chromium[III] complexes

Unlike chromium[VI] (potassium chromate), a chromic glycine complex did not produce unscheduled DNA synthesis in cultured human skin fibroblasts (Whiting *et al.*, 1979). In a differential killing assay with *E. coli* AB1157 (wild strain) and various repair-deficient strains and in the *S. typhimurium his⁻* reversion test, four of 17 hexacoordinate chromium[III] compounds gave positive results only in the DNA repair test and four in both tests (Warren *et al.*, 1981). The most active complexes were those containing aromatic amine ligands, like 2,2'-bipyridine and 1,10-phenanthroline. [The Working Group noted that the genotoxicity of these ligands was not checked.] Complexation with salicylate and citrate (but not with NTA, ethylenediaminetetraacetic acid, Tiron, glucose, glycine, pyrophosphate or acetate) rendered chromic chloride weakly active in the *rec* assay with *B. subtilis* (Gentile *et al.*, 1981). The mutagenicity of $[\text{Cr}(\text{bipy})_2\text{Cl}_2]\text{Cl}$ and $[\text{Cr}(\text{phen})_2\text{Cl}_2]\text{Cl}$ was confirmed in *S. typhimurium* TA100 (Beyersmann *et al.*, 1984). Water-soluble complexes of chromium[III] (chromic sulfate and chromic chloride) with five amino acids (arginine, aspartic acid, glycine, hydroxyproline and lysine) or with salicylic acid or ascorbic acid did not revert various *his⁻* *S. typhimurium* strains (Langerwerf *et al.*, 1985). Initial observations were reported in an abstract concerning the ability of $[\text{Cr}(\text{bipy})_2\text{Cl}_2]\text{Cl}$ to induce predominantly extragenic suppressors in TA103 (Vieux *et al.*, 1986). This complex was shown in the same laboratory to revert *his⁻* *S. typhimurium* TA92, TA100 and TA98 (Warren *et al.*, 1981). In a further abstract (Rogers *et al.*, 1987), the same compound was reported to revert TA102 and TA104, with an appreciable reduction of activity under anaerobiosis and in the presence of the hydroxyl ion scavenger mannitol. Exposure of calf thymus nuclei to $\text{Cr}(\text{glycine})_3$ produced DNA-protein cross-links as well as DNA strand-breaks, i.e., the same type of lesions caused by hexahydrated chromic chloride (Beyersmann & Köster,

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1987). In the same study, $[\text{Cr}(\text{phen})_2\text{Cl}_2]\text{Cl}$ also produced DNA fragmentation, but with a lower fraction of cross-links, when applied to intact Chinese hamster V79 cells; this phenanthroline complex, in contrast to $\text{Cr}(\text{glycine})_3$, also induced 6-thioguanine resistance. No mutagenic effect was detected in *his*⁻ *S. typhimurium* with a commercial preparation of glucose tolerance factor, a yeast-extracted natural complex of chromium[III] with nicotinic acid, glycine, glutamic acid and cysteine, which is prescribed as a dietary supplement in cases of deficient chromium[III] intake with food and impaired glucose tolerance (De Flora *et al.*, 1989a). $\text{Cr}(\text{maltolate})_3$, a chromium[III] complex with a low lipophilic ligand, did not induce gene mutations in *S. typhimurium* TA92, TA98, TA100 or TA104 nor sister chromatid exchange in mammalian cell culture (CHO line), whereas a complex with a high lipophilic ligand, $\text{Cr}(\text{acetyl acetonate})_3$, although inactive to TA92, TA98 and TA100 strains, was clearly mutagenic to strain TA104 and increased the frequency of sister chromatid exchange (Gava *et al.*, 1989a).

(iii) Chromium[VI] compounds

Potassium dichromate, sodium dichromate, ammonium dichromate, potassium chromate, sodium chromate, ammonium chromate and chromium trioxide

Highly soluble chromium[VI] compounds were assayed in several acellular systems. Potassium dichromate did not induce cross-links of *E. coli* [³H]DNA to bovine serum albumin (Fornace *et al.*, 1981). It inhibited DNA synthesis by decreasing nucleotide incorporation into calf thymus DNA in the presence of *E. coli* DNA polymerase (Nishio & Uyeki, 1985). Potassium dichromate (Sponza & Levis, 1980 [Abstract]; Bianchi *et al.*, 1983) and chromium trioxide (Sirover & Loeb, 1976; Tkeshelashvili *et al.*, 1980) decreased the fidelity of DNA synthesis by altering the ratio of incorporation of radiolabelled complementary to noncomplementary nucleotides. In these studies, the synthetic polynucleotide poly[d(A-T)] was used as a template in the presence of viral (avian myeloblastosis virus), bacterial (*E. coli*) and mammalian (calf thymus) DNA polymerase (Miyaki *et al.*, 1977). Chromium trioxide induced depurination in calf thymus DNA by enhancing the release of guanine, whereas no effect was produced on the release of adenine (Schaaper *et al.*, 1987). Potassium dichromate induced breakage in the polynucleotide chain of purified DNA and RNA, as inferred from studies of viscosity, ultraviolet absorption spectra and thermal denaturation patterns (Tamino & Peretta, 1980; Tamino *et al.*, 1981). Sodium chromate induced single-strand breaks in supercoiled circular DNA of the bacterial phage PM2, but only when combined with glutathione. Of two purified reaction products, the chromium[V] complex $\text{Na}_4(\text{glutathione})_4\text{CrV}_8\text{H}_2\text{O}$ cleared supercoiled PM2 DNA, whereas the final product, the chromium[III]-glutathione complex was inactive (Kortenkamp *et al.*, 1989). A positive (Tkeshelashvili *et al.*, 1980) and a negative result (Schaaper *et al.*, 1987) were reported for the

recovery of viral infectivity of single-stranded ϕ X174 DNA which, following treatment with chromium trioxide, was transfected into *E. coli* spheroplasts (*am*³ reversion). Potassium chromate induced *lacZ* α forward mutation in double-stranded M13mp2 DNA transfected into JM101 *E. coli* (Snow & Xu, 1989). Gel electrophoresis analysis demonstrated production of oligonucleotides from [³²P-5']-end-labelled DNA fragments treated with sodium chromate only in the presence of hydrogen peroxide (Kawanishi *et al.*, 1986). Several of these studies showed that chromium[VI] compounds are less active than chromium[III] compounds in simplified systems (See General Remarks, p. 43, for a discussion of the biological activity of chromium[VI] and chromium[III] compounds.)

DNA-damaging effects were observed by treating bacteria with highly soluble chromium[VI] compounds. Thus, potassium dichromate produced DNA fragmentation in strain WP2 of *E. coli*; this effect, detected by alkaline sucrose gradient sedimentation, was attenuated by α -tocopherol (Kalinina & Minseitova, 1983a,b). λ Prophage was induced by potassium chromate in *E. coli* WP2_s (Rossman *et al.*, 1984). An SOS response, inferred from induction of an SOS operator gene coupled with a gene coding for β -galactosidase in *E. coli*, was elicited by sodium dichromate in strain PQ37 (De Flora *et al.*, 1985a), by potassium dichromate, potassium chromate and chromium trioxide in strains GC2375, UA4202 and PQ30 (Llagostera *et al.*, 1986), and by potassium dichromate and potassium chromate in strain PQ37 (Venier *et al.*, 1989) and in strains PQ35 and PQ37 (Olivier & Marzin, 1987). Potassium dichromate also showed SOS-inducing activity in strain TA1535/pSK1002 of *S. typhimurium* (Nakamura *et al.*, 1987).

As shown by means of various techniques (spot test, streak method, treat-and-plate test, liquid test), soluble chromium[VI] compounds induce nonreparable DNA damage in repair-deficient bacteria. In particular, potassium dichromate, sodium dichromate, ammonium dichromate, potassium chromate, sodium chromate, ammonium chromate and chromium trioxide were active in the *rec* assay in *B. subtilis* in strains H17 (wild-type) and M45 (*rec*⁻) (Nishioka, 1975; Nakamuro *et al.*, 1978; Kada *et al.*, 1980; Kanematsu *et al.*, 1980; Matsui, 1980; Gentile *et al.*, 1981). Potassium dichromate, sodium dichromate, ammonium dichromate, sodium chromate and chromium trioxide were more toxic in strain TA1538 (*rec*⁻) than in the parental strain (TA1978) of *S. typhimurium* (Gentile *et al.*, 1981). Potassium dichromate, ammonium dichromate and potassium chromate were equally toxic in wild strain WP2 and in WP2*uvrA* (*uvrA*⁻) but more toxic in CM571 (*recA*⁻) and in WP100 (*uvrA*⁻*recA*⁻) than in WP2 (Yagi & Nishioka, 1977). Sodium dichromate was more toxic in TM1080 (*polA*⁻ *lexA*⁻ R factor) and CM871 (*uvrA*⁻*recA*⁻*lexA*⁻) than in the *E. coli* wild strain (WP2). No lethality was observed in WP2*uvrA* (*uvrA*⁻) or WP67 (*uvrA*⁻*polA*⁻) (Petrilli & De Flora, 1982). The lethality of sodium dichromate,

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potassium chromate, ammonium chromate and chromium trioxide to the triple mutant CM871 (*uvrA⁻recA⁻lexA⁻*) was greater than to WP2; this was not the case for WP67 (*uvrA⁻polA⁻*) (De Flora *et al.*, 1984a). [The Working Group noted that these results indicate the importance of the *rec* and *lex* SOS functions, rather than of the polymerase mechanism and *uvr* excision repair system, in repairing DNA damage produced by chromium[VI] in bacteria.]

Reversion to luminescence (bioluminescence test) was induced by potassium dichromate in strain Pf-13 of *Photobacterium fischeri* (Ulitzur & Barak, 1988). Reversion to *arg* autotrophy was induced by potassium dichromate and potassium chromate in *E. coli* strain Hs30R (Nakamuro *et al.*, 1978), and by sodium chromate in K12-343-113(λ) (Mohn & Ellenberger, 1977). The ability of soluble chromium[VI] compounds to revert *E. coli* to *trp* auxotrophy was reported by Venitt and Levy (1974) for sodium chromate (strains WP2 and WP2*uvrA*) and potassium chromate (WP2, WP2*uvrA* and WP2*exrA*), by Nishioka (1975) for potassium dichromate (WP2 and WP2*uvrA*, CM871 being insensitive), by Green *et al.* (1976) for potassium chromate (WP2), by Nestmann *et al.* (1979) for chromium trioxide (WP2*uvrA*, but only in a fluctuation test), by Petrilli and De Flora (1982) for sodium dichromate (WP2 and WP2*uvrA*), by Venitt and Bosworth (1983) for potassium dichromate (WP2*uvrA*, further increased under anaerobic growth conditions) and by Venier *et al.* (1987) for potassium dichromate (WP2*uvrA*, further increased by NTA). The only negative result was reported by Kanematsu *et al.* (1980), who identified potassium dichromate as a mutagen (in WP2*hcr⁻* only, WP2 *try⁻* being insensitive) but failed to detect the mutagenicity of chromium trioxide (in either WP2 or WP2*hcr⁻*). Potassium chromate had no effect on ultraviolet-induced mutagenesis in WP2 (Rossman & Molina, 1986).

The mutagenicity of soluble chromium[VI] compounds in *his⁻ S. typhimurium* and its modulation were investigated in a large number of laboratories, using various techniques (spot test, spiral test, plate test and preincubation test). A number of studies yielded positive results (Tamaro *et al.*, 1975; Petrilli & De Flora, 1977; De Flora, 1978; Petrilli & De Flora, 1978b; Nestmann *et al.*, 1979; De Flora, 1981a,b; Tso & Fung, 1981; Petrilli & De Flora, 1982; Venier *et al.*, 1982; Bennicelli *et al.*, 1983; Bianchi *et al.*, 1983; Beyersmann *et al.*, 1984; De Flora *et al.*, 1984a,b; Arlauskas *et al.*, 1985; Langerwerf *et al.*, 1985; Loprieno *et al.*, 1985; Marzin & Phi, 1985; LaVelle, 1986a,b; Vieux *et al.*, 1986 [Abstract]; Farrell *et al.*, 1989). Negative results were reported in all the strains tested in one study only (Kanematsu *et al.*, 1980) [doses were not reported]. Using the replicate plate technique, Pedersen *et al.* (1983) claimed that a high proportion of *S. typhimurium his⁺* revertant colonies were false, but this conclusion was criticized by Baker *et al.* (1984), using the same technique. In general, with the exception of TA1535, all *his⁻ S. typhimurium* strains tested were reverted by chromium[VI]. The following ranking of sensitivity was reported:

TA102 > TA100 > TA97 > TA92 > TA1978 > TA98 > TA1538 > TA1537 (Benicelli *et al.*, 1983). Other sensitive strains included TA103 (Gava *et al.*, 1989b), TA104 (De Flora *et al.*, 1988; Gava *et al.*, 1989b), TA94 (Langerwerf *et al.*, 1985), TS26 (La Velle, 1986a) and GV19 (La Velle, 1986b). The nitroreductase-deficient derivative strain TA100NR was even more sensitive than TA100, which suggests a diminution of the mutagenicity of chromium[VI] by bacterial nitroreductases (De Flora *et al.*, 1989b). Reversion patterns indicate that chromium[VI] induces frame-shift errors in bacterial DNA and, to a greater extent, base-pair substitution at both GC base-pairs (TA100) and AT base-pairs (TA102, TA104). The latter two strains are known to be sensitive to oxidative mutagens. In any case, the presence of plasmid pKM101 in the most sensitive strains indicates that the mutagenicity of chromium[VI] is amplified through error-prone DNA repair pathways, which is consistent with the results of the DNA-repair tests reported above. The potency of chromium[VI] compounds correlated with their chromium[VI] content, being in the range of a few revertants per nanomole chromium[VI] in TA100 and TA102 (De Flora, 1981a; De Flora *et al.*, 1984a,b). Since the potency of mutagens of various chemical classes tested in the same laboratory varied between 2×10^{-6} and 1.4×10^4 revertants/nmol (6.8×10^9 -fold range), chromium[VI] compounds can be classified as mutagens of medium potency in this test system (De Flora *et al.*, 1984b).

The bacterial mutagenicity of potassium dichromate was also confirmed in forward mutation assay in *E. coli*, testing acquired resistance to rifampicin in AB1157 and derived *recA*⁻, *recB*⁻, *recC*⁻, *recF*⁻ and *sbc*⁻ strains (Kalinina & Minseitowa, 1983b,c), *lacI*⁺/*lacI*⁻ mutation in strain KMBL3835 (Zakour & Glickman, 1984), and replication of integrated λ genes in strain CHY832 (RK test) (Hayes *et al.*, 1984). Chromium trioxide induced Ara^r forward mutation in strains BA9 and BA13 of *S. typhimurium* (Ruiz-Rubio *et al.*, 1985). Potassium chromate did not induce forward or back mutations in a fluctuation test with K-12-derived *E. coli* strains but enhanced the frameshift mutagenicity of 9-aminoacridine (La Velle, 1986a).

Reducing chemicals (ascorbic acid and sodium sulfite) and glutathione, NADH and NADPH decreased the bacterial mutagenicity of various chromium[VI] compounds (Petrilli & De Flora, 1978b; De Flora *et al.*, 1985b; Petrilli *et al.*, 1986a). A similar reducing effect was induced by other sulfur compounds, such as *N*-acetylcysteine (De Flora *et al.*, 1984c), cysteine (Petrilli *et al.*, 1986a) and dithiothreitol (Rogers *et al.*, 1987 [Abstract]). The mutagenicity of potassium dichromate was also considerably decreased by anaerobic growth conditions, but not by addition of the hydroxyl ion scavenger mannitol (Rogers *et al.*, 1987 [Abstract]). The mutagenicity of soluble chromium[VI] compounds was not affected or was poorly affected by addition of soda ash, diethyl ether, prostaglandin or ethylenediamine-tetraacetic acid (Petrilli & De Flora, 1982; Petrilli *et al.*, 1986a) or complex mixtures

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(crude oil, oil dispersants) (Petrilli *et al.*, 1980; De Flora *et al.*, 1985a), whereas it was inhibited by other metals (Sokolowska & Jongen, 1984 [Abstract]). Sodium dichromate and unfractionated cigarette smoke condensate had antagonistic mutagenic effects (Petrilli & De Flora, 1982). The mutagenicity of potassium dichromate was increased by nitrilotriacetic acid (Gava *et al.*, 1989a). Potassium chromate decreased the mutagenicity of ethyl methanesulfonate and increased that of sodium azide (LaVelle & Witmer, 1984) and of its metabolite azidoalanine (LaVelle, 1986b); more than additive effects were observed with 9-aminoacridine (LaVelle, 1986a).

The mutagenicity of soluble chromium[VI] compounds in *S. typhimurium* was consistently decreased by rat liver post-mitochondrial supernatant in all studies in which this aspect was evaluated (De Flora, 1978; Löfroth, 1978; Petrilli & De Flora, 1978b; Nestmann *et al.*, 1979; Petrilli & De Flora, 1980; De Flora, 1981a; Petrilli & De Flora, 1982; Venier *et al.*, 1982; Bianchi *et al.*, 1983; De Flora *et al.*, 1984a; Loprieno *et al.*, 1985; Petrilli *et al.*, 1986b). The polychlorinated biphenyl Aroclor 1254 was the most efficient inducer of this effect, followed in activity by phenobarbital and 3-methylcholanthrene (Petrilli *et al.*, 1985). Pretreatment of rats with *N*-acetylcysteine also stimulated reduction of chromium[VI] by liver and lung post-mitochondrial supernatant (De Flora *et al.*, 1985c). The effect of the rat liver fraction on the mutagenicity of various chromium[VI] compounds was inhibited by dicoumarol, a specific inhibitor of the cytosolic enzyme DT diaphorase (De Flora *et al.*, 1987b); purified DT diaphorase itself decreased the mutagenicity of sodium dichromate (De Flora *et al.*, 1988). The mutagenicity of sodium dichromate was also decreased by liver preparations from other animal species, including fish (*Salmo gairdneri*) (De Flora *et al.*, 1982), chicken, hamster (De Flora *et al.*, 1985d), Pekin duck (De Flora *et al.*, 1989a), mouse (De Flora, 1982), woodchuck (De Flora *et al.*, 1987c, 1989c) and humans (De Flora, 1982). Moreover, mutagenicity was decreased by thermostable components of human gastric juice (De Flora & Boido, 1980; De Flora *et al.*, 1987a), with peaks of reducing activity during post-meal periods following stimulation of gastric secretion (De Flora *et al.*, 1987a). Human erythrocyte lysates decreased the mutagenicity of chromium[VI] (Petrilli & De Flora, 1978b); human and rat pulmonary alveolar macrophages were particularly efficient (Petrilli *et al.*, 1986c). Human peripheral lung parenchyma decreased the mutagenicity of chromium[VI] more efficiently than a post-mitochondrial supernatant of bronchial tree (Petruzzelli *et al.*, 1989); as assessed from 71 surgical specimens from cancer and noncancer patients, the ability of lung parenchyma to decrease the mutagenicity of chromium[VI] was significantly enhanced in cigarette smokers (De Flora *et al.*, 1987d). In rats, the inhibitory effect of lung was autoinduced by repeated intratracheal instillations of sodium dichromate (Petrilli *et al.*, 1985). Comparative assays provided evidence that the reducing capacity of rat tissue post-mitochondrial supernatant ranked as follows: liver > adrenal > kidney >

testis > stomach and lung; preparations of skeletal muscle, spleen and intestine had no effect on the mutagenicity of chromium[VI] (Petrilli & De Flora, 1978b, 1980, 1982). Further assays confirmed the negligible effect of rat muscle (which is a typical target of the carcinogenicity of chromium[VI] in bioassays) in decreasing the mutagenicity of chromium[VI], as compared to liver and, to a lesser extent, to cutis and subcutis (De Flora *et al.*, 1989a). The selective loss of chromium[VI] mutagenicity was accompanied by the disappearance of measurable chromium[VI] in the presence of various body fluids and cell and tissue preparations. [The Working Group interpreted these findings as indicating mechanisms that limit the activity of chromium[VI] compounds *in vivo*.]

Forward mutation and mitotic gene conversion were induced by potassium dichromate in the yeast *Schizosaccharomyces pombe* (Bonatti *et al.*, 1976). The same compound induced reversion (*ilv⁻ → ilv⁺*) and mitotic gene conversion in strain D7 of *Saccharomyces cerevisiae* (Singh, 1983; Galli *et al.*, 1985; Kharab & Singh, 1985). Conversely, chromium trioxide elicited gene conversion and mitotic crossing-over but failed to revert the same yeast strain (Fukunaga *et al.*, 1982). Potassium dichromate slightly enhanced recombination frequency in strain D1513 of *Saccharomyces cerevisiae* and produced disomic and diploid gametes (Sora *et al.*, 1986), but it did not induce mitochondrial 'petite' mutants in strain D7 (Kharab & Singh, 1987).

Neither potassium chromate nor chromium trioxide induced micronuclei in pollen mother cells of *Tradescantia paludosa* (Ma *et al.*, 1984). In contrast, further studies indicated a dose-dependent increase in the induction of micronuclei by chromium trioxide, which was significantly inhibited by cysteine (Zhang *et al.*, 1984).

In *Drosophila melanogaster*, sodium dichromate gave positive results in a somatic eye-colour test (*zeste* mutation) (Rasmuson, 1985). Both potassium dichromate and chromium trioxide induced sex-linked recessive lethal mutations, but only potassium dichromate induced non-disjunction and X-Y chromosome loss at a dose corresponding to the LD₅₀ (Rodriguez-Arnaiz & Molina Martinez, 1986). The induction of sex-linked recessive lethal mutations by potassium dichromate was enhanced by NTA (Gava *et al.*, 1989b).

A variety of genetic and related endpoints were explored in cultured mammalian cells. Potassium dichromate produced alterations of the mitotic index and of mitotic phases in human epithelial-like heteroploid HEp-2 cells (Majone, 1977; Levis & Majone, 1981) and NHIK 3025 cervix tissue cells (Bakke *et al.*, 1984), and imbalance of the endogenous adenylate pool in Syrian hamster BHK fibroblasts (Levis *et al.*, 1978b; Bianchi *et al.*, 1982a). It inhibited DNA synthesis, as evaluated by ³H-thymidine incorporation, in mouse L cells (Nishio & Uyeki, 1985), in BHK fibroblasts and in HEp-2 cells (Levis *et al.*, 1977, 1978a,b), in which a secondary inhibition of RNA and protein syntheses was also observed (Levis *et al.*, 1978b).

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Inhibition of DNA synthesis was further enhanced following reversible permeabilization of cells in hypertonic medium (Bianchi *et al.*, 1984). Potassium dichromate also reduced the colony-forming ability of BHK cells by a multi-hit mechanism of cell inactivation (Levis *et al.*, 1978a). Unscheduled DNA synthesis was induced by potassium dichromate in mouse kidney A18BcR cells (Raffetto *et al.*, 1977) but not in human EUE heteroploid cells (Bianchi *et al.*, 1982b, 1983); potassium chromate induced unscheduled DNA synthesis in human skin fibroblasts (Whiting *et al.*, 1979). Chromium trioxide inhibited repair of γ -ray-induced chromosome breaks in human peripheral blood lymphocytes (Morimoto & Koizumi, 1981).

DNA fragmentation and cross-links were produced by soluble chromium[VI] compounds in a number of cultured mammalian cell lines, as assessed by various techniques, including alkaline elution, alkaline sucrose gradient, nucleoid sedimentation, alkaline unwinding, the nick translation assay, and polyacrylamide gel electrophoresis (Table 25). An exception was a study by alkaline elution in Chinese hamster V79 cells with potassium dichromate (Bianchi *et al.*, 1983).

In the *hprt* forward mutation assay, potassium chromate did not induce 8-azaguanidine-resistant mutants in mouse mammary carcinoma FM3A cells, in contrast to the activity of potassium dichromate and chromium trioxide in the same system (Nishimura & Umeda, 1978 [Abstract]). An unspecified chromate induced 6-thioguanine resistance in Chinese hamster V79 cells (Beyersmann & Köster, 1987). Potassium dichromate induced 8-azaguanidine resistance and 6-thioguanidine resistance in Chinese hamster V79 cells (Newbold *et al.*, 1979; Rainaldi *et al.*, 1982; Paschin *et al.*, 1981; Bianchi *et al.*, 1983); its mutagenic activity was decreased by thiotepa (Paschin & Kozachenko, 1982), unaffected by nitrilotriacetic acid (Celotti *et al.*, 1987) and enhanced by nickel[II] (Hartwig & Beyersmann, 1987). In comparative assays, Chinese hamster V79 cells were found to be more sensitive to chromium[VI] than Chinese hamster CHO cells (Paschin *et al.*, 1983). The combined use of selective 8-azaguanidine-resistant and ouabain-resistant systems showed that potassium dichromate can also induce base-pair substitutions in the DNA of V79 cells (Rainaldi *et al.*, 1982). Potassium dichromate and potassium chromate induced forward mutation at the thymidine kinase locus in mouse lymphoma L5178Y cells (Oberly *et al.*, 1982). As assessed in an assay for the synthesis of P-100^{gag-mos} viral proteins, sodium chromate induced expression of the *v-mos* gene in MuSVts110-infected rat kidney 6m2 cells (Biggart & Murphy, 1988).

Soluble chromium[VI] compounds consistently increased the frequency of sister chromatid exchange (Table 26). The highest frequency of induction was observed in the early S-phase of the human lymphocyte cycle (Stella *et al.*, 1982).

Table 25. Studies in which DNA fragmentation and DNA-DNA and DNA-protein cross-linking were induced in cultured mammalian cells by soluble chromium[VI] compounds

Chromium compound	Cell line	Comment	Reference
Potassium dichromate	Mouse L1210 leukaemia Novikoff ascitic hepatoma Chinese hamster CHO		Fornace <i>et al.</i> (1981) Wedrychowski <i>et al.</i> (1986a) Brambilla <i>et al.</i> (1980) [Abstract]; Hamilton-Koch <i>et al.</i> (1986)
	Human foreskin HSBP fibroblasts	Detected by alkaline sucrose gradient but not nick translation, nucleoid sedimentation or alkaline un- winding Enhanced by glutathione, unaffected by hydroxyl radical scavengers (mannitol, iodine), diminished by superoxide dismutase and catalase	Hamilton-Koch <i>et al.</i> (1986); Snyder (1988)
	Human white blood		McLean <i>et al.</i> (1982)
Sodium dichromate	Rat primary hepatocytes		Sina <i>et al.</i> (1983)
Potassium chromate	Mouse L1210 leukaemia Chinese hamster CHO fibroblasts Human embryo lung IMR-90 fibroblasts Human skin fibroblasts Human CRL1223 fibroblasts Human AG1522 fibroblasts Human XP12BE fibroblasts	DNA-protein cross-linkage, probably due to chromium[III] At 7th-8th passage Similar effect in normal xeroderma pigmentosum cells	Fornace <i>et al.</i> (1981) Miller & Costa (1988, 1989) Fornace <i>et al.</i> (1981) Whiting <i>et al.</i> (1979) Fornace (1982) Fornace (1982) Fornace (1982)
	Novikoff ascitic hepatoma Human bronchial epithelium		Wedrychowski <i>et al.</i> (1986b) Fornace <i>et al.</i> (1981)

Table 25 (contd)

Chromium compound	Cell line	Comment	Reference
Sodium chromate	Chick embryo hepatocytes	Related to glutathione and cytochrome P450 metabolism	Tsapakos <i>et al.</i> (1983b); Cupo & Wetterhahn (1984, 1985b)
	Chinese hamster V79	Decreased by α -tocopherol; increased by riboflavin and sodium sulfite; DNA-protein breaks recognized by poly(ADT-ribose)polymerase	Sugiyama <i>et al.</i> (1987, 1988)
Chromium trioxide	Novikoff ascitic hepatoma		Wedrychowski <i>et al.</i> (1986a)

Table 26. Studies in which sister chromatid exchange was induced in cultured mammalian cells by chromium[VI] compounds

Chromium compound	Cell line	Comment ^a	Reference
Potassium dichromate	Mouse lymphocytes LSTRA		Bianchi <i>et al.</i> (1983)
	BALB mouse primary lymphocytes	BALB cells carrying endogenized Moloney leukaemia virus more sensitive than uninfected cells	Bianchi <i>et al.</i> (1983); Majone <i>et al.</i> (1983)
	Mouse macrophage P388D,		Andersen (1983)
	Mouse embryo blastocytes		Iijima <i>et al.</i> (1983b)
	Chinese hamster CHO		Levis & Majone (1979); Majone & Levis (1979); Bianchi <i>et al.</i> (1980); Levis & Majone (1981); Majone <i>et al.</i> (1982); Venier <i>et al.</i> (1982); Bianchi <i>et al.</i> (1983); Uyeki & Nishio (1983); Loprieno <i>et al.</i> (1985); Montaldi <i>et al.</i> (1987b)
	Chinese hamster V79		Rainaldi <i>et al.</i> (1982)
	Chinese hamster lung Don		Ohno <i>et al.</i> (1982)
	Syrian hamster BHK fibroblasts	Increased in permeabilized cells	Bianchi <i>et al.</i> (1984)
	Human peripheral blood lymphocytes		Ogawa <i>et al.</i> (1978); Gómez-Arroyo <i>et al.</i> (1981); Imreh & Radulescu (1982 [Abstract]); Stella <i>et al.</i> (1982); Andersen (1983)
	Human skin fibroblasts		Macrae <i>et al.</i> (1979)
Sodium dichromate	Chinese hamster CHO		Levis & Majone (1979); Majone & Levis (1979); Bianchi <i>et al.</i> (1980)
	Chinese hamster V79		Elias <i>et al.</i> (1983)
Potassium chromate	Chinese hamster CHO		Levis & Majone (1979); Macrae <i>et al.</i> (1979); Majone & Rensi (1979); Bianchi <i>et al.</i> (1980); Majone <i>et al.</i> (1982)
	Chinese hamster V79		Price-Jones <i>et al.</i> (1980); Elias <i>et al.</i> (1983)

Table 26 (contd)

Chromium compound	Cell line	Comment ^a	Reference
Potassium chromate (contd)	Chinese hamster lung Don		Ohno <i>et al.</i> (1982)
	Human skin fibroblasts		Macrae <i>et al.</i> (1979)
	Human peripheral blood lymphocytes		Douglas <i>et al.</i> (1980)
Sodium chromate	Chinese hamster CHO		Levis & Majone (1979); Bianchi <i>et al.</i> (1980)
	Chinese hamster V79		Elias <i>et al.</i> (1983)
Chromium trioxide	Chinese hamster CHO		Levis & Majone (1979); Bianchi <i>et al.</i> (1980)
	Chinese hamster lung Don		Koshi (1979); Ohno <i>et al.</i> (1982)
	Human peripheral blood lymphocytes		Gómez-Arroyo <i>et al.</i> (1981)
Calcium chromate	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b); Sen & Costa (1986)
Lead chromate	Human peripheral blood lymphocytes	Dissolved in NaOH	Douglas <i>et al.</i> (1980)
Strontium chromate	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b)
Zinc chromates	Chinese hamster CHO	Increased in presence of NaOH or NTA	Levis & Majone (1981); Venier <i>et al.</i> (1985b)
	Chinese hamster V79		Elias <i>et al.</i> (1983)
Basic zinc chromates	Chinese hamster CHO	Increased in presence of NaOH or NTA	Levis & Majone (1981); Venier <i>et al.</i> (1985b)
Zinc chromate	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b)
Barium chromate	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b)

Table 26 (contd)

Chromium compound	Cell line	Comment ^a	Reference
Lead chromate	Chinese hamster CHO	Increased in presence of NTA	Montaldi <i>et al.</i> (1987a,b)
	Chinese hamster CHO	Increased in presence of NTA	Loprieno <i>et al.</i> (1985)
	Human peripheral blood lymphocytes	Dissolved in NaOH	Douglas <i>et al.</i> (1980)
Chromium yellow	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b)
	Chinese hamster CHO	Increased in presence of NaOH	Levis & Majone (1981)
Chromium orange	Chinese hamster CHO	Increased in presence of NaOH	Levis & Majone (1981)
	Chinese hamster CHO		Loprieno <i>et al.</i> (1985)
Molybdenum orange	Chinese hamster CHO	Increased in presence of NTA	Venier <i>et al.</i> (1985b)
	Chinese hamster CHO	Increased in presence of NaOH	Levis & Majone (1981)

^aNTA, nitrilotriacetic acid

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As reported in an abstract, potassium dichromate also increased the frequency of micronucleated cells in human lymphocytes cultured *in vitro* (Imreh & Radulescu, 1982).

In many studies, the induction of chromosomal aberrations was investigated, often in parallel with assessments of the frequency of sister chromatid exchange; all of them gave positive results (Table 27). Chromatid-type aberrations, mainly gaps, breaks and chromatid exchanges, were the most frequently reported aberrations (Levis & Bianchi, 1982).

Two studies dealt with the induction of aneuploidy by soluble chromium[VI] salts in cultured mammalian cells: no increase in the number of aneuploids or polyploids was detected following treatment of Chinese hamster V79 cells with potassium chromate (Price-Jones *et al.*, 1980). Sodium chromate, however, exhibited spindle-modifying properties in human skin fibroblasts, as assessed by means of a differential staining technique for chromosomes and spindles, alterations in which may represent one of the major causes of aneuploidy (Nijs & Kirsch-Volders, 1986).

The majority of studies provided evidence that soluble chromium[VI] salts can induce cell transformation in different experimental systems. In particular, as evaluated by means of the soft agar assay, potassium dichromate produced anchorage-independent growth of Syrian hamster BHK fibroblasts (Bianchi *et al.*, 1983; Hansen & Stern, 1985), which was further enhanced in the presence of NTA (Lanfranchi *et al.*, 1988). [See General Remarks, p. 44, for concern about this assay.] The same compound induced morphological transformation of Syrian hamster embryo (SHE) primary cells (Tsuda & Kato, 1977; Hansen & Stern, 1985) and of mouse fetal cells at the third passage (Raffetto *et al.*, 1977), whereas a negative result was reported in mouse embryo C3H10T1/2 cells (Patierno *et al.*, 1988). [See General Remarks, p. 44, for concerns about this assay.] Sodium chromate also induced morphological transformation of SHE primary cells (DiPaolo & Casto, 1979), but potassium chromate did not, although it potentiated the transforming capacity of benzo[a]pyrene (Rivedal & Sanner, 1981); it also enhanced the morphological transformation induced by the simian adenovirus SA7 in SHE primary cells (Casto *et al.*, 1979).

Several studies were also carried out with soluble chromium[VI] compounds *in vivo*. Following intraperitoneal injection to Sprague-Dawley rats, sodium dichromate induced a selective DNA fragmentation in different tissues, as assessed by means of the alkaline elution technique. In particular, liver nuclei contained protein-associated DNA single-strand breaks as well as DNA-protein cross-links, whereas kidney nuclei contained mainly DNA-protein cross-links (Tsapakos *et al.*, 1981) and lung nuclei contained both DNA interstrand and DNA-protein cross-links (Tsapakos *et al.*, 1983a). These lesions were repaired most rapidly in the liver, which may provide a partial explanation of the differential toxicity of

Table 27. Studies in which chromosomal aberrations were induced in cultured mammalian cells by chromium[VI] compounds

Chromium compound	Cell line	Comment ^a	Reference
Potassium dichromate	Mouse tertiary fetal		Raffetto <i>et al.</i> (1977)
	Mouse mammary carcinoma Fm3A		Umeda & Nishimura (1979)
	Rat peripheral blood lymphocytes		Newton & Lilly (1986)
	Rat embryo fibroblasts		Bigaliev <i>et al.</i> (1977a)
	Syrian hamster embryo primary	Inhibited by sodium sulfite	Tsuda & Kato (1977)
	Chinese hamster CHO		Levis & Majone (1979); Majone & Levis (1979); Bianchi <i>et al.</i> (1980); Levis & Majone (1981); Venier <i>et al.</i> (1982)
	Chinese hamster V79		Newbold <i>et al.</i> (1979)
Sodium dichromate	Human peripheral blood lymphocytes		Nakamuro <i>et al.</i> (1978); Imreh & Radulescu (1982 [Abstract]); Stella <i>et al.</i> (1982)
	Chinese hamster CHO		Levis & Majone (1979); Majone & Levis (1979); Bianchi <i>et al.</i> (1980)
	Human peripheral blood lymphocytes		Sarto <i>et al.</i> (1980)
Potassium chromate	Mouse mammary carcinoma Fm3A		Umeda & Nishimura (1979)
	Chinese hamster CHO		Levis & Majone (1979); Majone & Rensi (1979); Bianchi <i>et al.</i> (1980)
	Chinese hamster lung Don		Koshi & Iwasaki (1983)
	Human skin fibroblasts		Macrae <i>et al.</i> (1979)
	Human peripheral blood lymphocytes		Nakamuro <i>et al.</i> (1978); Douglas <i>et al.</i> (1980)
Sodium chromate	Chinese hamster CHO		Levis & Majone (1979); Bianchi <i>et al.</i> (1980)

Table 27 (contd)

Chromium compound	Cell line	Comment ^a	Reference
Chromium trioxide	Mouse mammary carcinoma Fm3A		Umeda & Nishimura (1979)
	Syrian hamster embryo primary		Tsuda & Kato (1977)
	Chinese hamster CHO		Levis & Majone (1979); Bianchi <i>et al.</i> (1980)
	Chinese hamster lung Don		Koshi (1979)
	Human peripheral blood lymphocytes		Kaneko (1976)
Calcium chromate	Mouse embryo C3H10T1/2	Random damage	Sen <i>et al.</i> (1987)
	Chinese hamster CHO	Random damage	Levis & Majone (1979); Sen <i>et al.</i> (1987)
	Chinese hamster lung Don		Koshi & Iwasaki (1983)
Basic zinc chromates	Chinese hamster CHO	Increased in presence of NaOH	Levis & Majone (1981)
Zinc chromate	Chinese hamster lung Don		Koshi & Iwasaki (1983)
Lead chromate	Chinese hamster CHO	Increased in presence of NaOH or NTA	Levis & Majone (1981); Montaldi <i>et al.</i> (1987b)
	Chinese hamster lung Don		Koshi & Iwasaki (1983)
	Human peripheral blood lymphocytes	Increased in presence of NaOH	Douglas <i>et al.</i> (1980)

^aNTA, nitrilotriacetic acid

chromium[VI] in these organs (Tsapakos *et al.*, 1983a). Following its injection onto the inner shell membrane of eggs, sodium dichromate produced single-strand breaks in blood cells and DNA cross-links in liver cells of chicken embryos (Hamilton & Wetterhahn, 1986). Intraperitoneally injected potassium dichromate inhibited DNA repair synthesis in rat lymphocytes (Rudnykh & Saichenko, 1985); it was active in a mammalian spot test in C57Bl/6J/BOM mice, but only when administered at 10 mg/kg and not at 20 mg/kg (Knudsen, 1980).

Intraperitoneal injection of potassium dichromate or potassium chromate to Chinese hamsters induced sister chromatid exchange in bone-marrow cells and an increased frequency of micronucleated polychromatic erythrocytes (Kaths, 1981). Micronucleated polychromatic erythrocytes were also enhanced by potassium dichromate in BALB/c mice (Fabry, 1980) and in CBA \times C57Bl/6J mice (Paschin & Toropsev, 1982, 1983) and by potassium chromate in NMRI mice (Wild, 1978), ms and ddY mice, the former strain being more sensitive (Hayashi *et al.*, 1982). Comparative trials in various mouse strains showed no important sex-related variation in induction of micronucleated cells by chromium[VI] and confirmed the different susceptibilities of different strains (rank of sensitivity: ms > BDF1 > CD-1 > ddY) (Collaborative Study Group for the Micronucleus Test, 1986, 1988).

Chromosomal aberrations were induced in gill tissue cells of *Boleophthalmus dussumieri* fish by intramuscular injection or addition to water of sodium dichromate (Krishnaja & Rege, 1982). Potassium dichromate induced chromosomal rearrangements and aneuploidy in rat bone-marrow cells when given orally or intratracheally (Bigaliev *et al.*, 1977b). Following intraperitoneal or intravenous injection, it produced chromosomal aberrations in lymphocytes and bone-marrow cells (Newton & Lilly, 1986). Intraperitoneal injection of potassium dichromate was also clastogenic to bone-marrow cells of BALB/c mice (Léonard & Deknuds, 1981 [Abstract]), but no increase in chromosomal aberrations was observed in CBA \times C57Bl/6J hybrid mice (Paschin *et al.*, 1981). In the same animals, dominant lethal effects were produced at 2 mg/kg bw (21 doses) and 20 mg/kg bw (single dose) (Paschin *et al.*, 1982) but not at 0.5-1.5 mg/kg bw (single dose) (Paschin *et al.*, 1981). At 20 mg/kg bw, potassium dichromate reduced the rate of pregnancies in BALB/c mice (Léonard & Deknuds, 1981 [Abstract]; Deknuds, 1982 [Abstract]) but failed to produce dominant lethal effects (Léonard & Deknuds, 1981 [Abstract]).

Calcium chromate, strontium chromate, basic zinc chromate

Calcium chromate, strontium chromate and the industrial product, basic zinc chromate or zinc yellow [$\text{ZnCrO}_4 \cdot \text{Zn}(\text{OH})_2$ plus 10% CrO_3], are generally completely dissolved in the media used in short-term tests. The results obtained in a variety of experimental systems thus virtually overlap with those reported for highly soluble chromium[VI] compounds.

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Calcium chromate failed to induce an SOS response in strain PQ37 of *E. coli* (Brams *et al.*, 1987). In contrast, it was active in a differential killing assay in *E. coli* WP2, using the triple mutant CM871 (*uvrA⁻ recA⁻ lexA⁻*) (De Flora *et al.*, 1984a), and in the *trp⁻ → trp⁺* reversion test with strains WP2 (Venitt & Levy, 1974) and WP2*uvrA* (Dunkel *et al.*, 1984). In the *his⁻ → his⁺* reversion test in *S. typhimurium*, positive results were reported with calcium chromate (Petrilli & De Flora, 1977; De Flora, 1981a; Bennicelli *et al.*, 1983; Haworth *et al.*, 1983; De Flora *et al.*, 1984a, 1987b; Dunkel *et al.*, 1984; Petrilli *et al.*, 1985; Venier *et al.*, 1985b), strontium chromate (Venier *et al.*, 1985b) and zinc yellow (Petrilli & De Flora, 1978b; De Flora, 1981a). The potency, spectrum of sensitivity of *S. typhimurium* strains and behaviour in the presence of in-vitro metabolic systems were comparable to those reported for highly soluble chromium[VI] compounds. However, toxic effects of calcium chromate hampered the detection of forward and back mutations in the DNA of phage T4 grown in *E. coli* BB (Corbett *et al.*, 1970).

Calcium chromate induced 'petite' mutants in mitochondria of 19 haploid strains of *Saccharomyces cerevisiae* (Egilsson *et al.*, 1979) and produced differential chromosome breakage in excision-repair-deficient females of *Drosophila melanogaster* (*mei-9^a* test), with complete loss of the X or Y and partial loss of the Y chromosome (Zimmering, 1983).

Zinc yellow produced alterations of the mitotic cycle in human epithelial-like heteroploid HEp-2 cells (Levis & Majone, 1981). Calcium chromate stimulated DNA repair replication in Syrian hamster embryo primary cells, as evaluated by caesium chloride gradient density sedimentation (Robison *et al.*, 1984). It also produced DNA single-strand breaks, DNA interstrand and DNA-protein cross-links (alkaline elution technique) in mouse embryo C3H10T1/2 cells, Chinese hamster CHO cells and human osteosarcoma cells, the maximal sensitivity being recorded in early S-phase (Sugiyama *et al.*, 1986a,b); human cells were more sensitive than mouse or hamster cells (Sugiyama *et al.*, 1986b). In Chinese hamster CHO cells, calcium chromate produced single-strand breaks, induced alkali-labile sites (Cantoni & Costa, 1984) and, as assessed by alkaline sucrose gradient, decreased the DNA molecular weight (Robison *et al.*, 1982). DNA cross-links were more pronounced and only partially repaired in a repair-deficient line (EM9) as compared with CHO wild-type cells (AA8). Conversely, repair of single-strand breaks was similar in the two cell lines (Christie *et al.*, 1984). Calcium chromate produced strand breaks, detected by nucleoid gradient sedimentation, when applied to intact cells, but no breakage was observed when nucleoids were exposed directly to chromium[VI] (Robison *et al.*, 1984).

Calcium chromate induced forward mutation at the thymidine kinase locus in mouse lymphoma L5178Y cells, with no change (Myhr & Caspary, 1988) or decreased activity (McGregor *et al.*, 1987; Mitchell *et al.*, 1988) in the presence of rat

liver post-mitochondrial supernatant. This salt induced dose-dependent cytotoxicity and forward mutation to 6-thioguanine resistance in Chinese hamster CHO cells but no mutation to ouabain resistance in the same cells or in mouse embryo C3H10T1/2 cells (Patierno *et al.*, 1988).

The frequency of sister chromatid exchange was increased in Chinese hamster CHO cells by all three compounds (Table 26). In contrast to nickel, no predominance of sister chromatid exchange was observed in heterochromatic regions (Sen & Costa, 1986). Chromosomal aberrations, with a random distribution of chromosomal damage, were produced by calcium chromate and zinc yellow (Table 27). Aberrant division patterns and spindle modifications were also caused by calcium chromate in human skin fibroblasts (Nijs & Kirsch-Volders, 1986).

Several authors reported that calcium chromate could determine cell transformation *in vitro* in different systems: anchorage-independent growth of Syrian hamster BHK fibroblasts in carboxymethylcellulose, after several passages of treated cells (Fradkin *et al.*, 1975) or in soft agar (Bianchi *et al.*, 1983; Hansen & Stern, 1985), with an enhancing effect in the presence of NTA (Lanfranchi *et al.*, 1988), attachment-independence of virus-infected rat embryo 2 FR₄ 50 cells (Traul *et al.*, 1981) [see General Remarks for concern about this assay], morphological transformation of mouse BALB/3T3 cells, R-MuLV-infected rat embryo cells and Syrian hamster embryo primary cells (Dunkel *et al.*, 1981); and enhancement of morphological transformation in the same cells by the simian adenovirus SA7 (Casto *et al.*, 1979). As reported for potassium dichromate, calcium chromate did not induce morphological transformation in mouse embryo C3H10T1/2 cells (Patierno *et al.*, 1988).

Conflicting results were reported in studies *in vivo* with calcium chromate. It increased the frequency of sister chromatid exchange in bone-marrow cells of intraperitoneally injected Chinese hamsters (Kaths, 1981), whereas it failed to increase micronuclei in bone-marrow polychromatic erythrocytes of intraperitoneally injected BALB/c mice (Fabry, 1980) or Chinese hamsters (Kaths, 1981), and did not induce dominant lethal mutations in BALB/c mice (Léonard & Deknuddt, 1981 [Abstract]).

Zinc chromate, barium chromate, lead chromate and derived pigments (chromium orange, chromium yellow and molybdenum orange)

An extensive data base is available concerning chromium[VI] compounds with poor solubility under the conditions used in experimental systems. These are zinc chromate, chromium orange or basic lead chromate [(PbCrO₄.PbO)], molybdenum orange (PbCrO₄.PbSO₄.PbMoO₄), barium chromate, chromium yellow (PbCrO₄.PbSO₄.SiO₂.Al₂O₃) and lead chromate, which is one of the most insoluble salts. As is to be expected, their activity in short-term tests was related to the availability of chromate to target cells, which was often achieved by artificial solubiliza-

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tion in acids or alkali, except in mammalian cells, where some penetration of insoluble compounds is likely to occur by phagocytosis.

Lead chromate did not induce differential killing in *E. coli* W3110 or P3478 (*polA*⁻), even when dissolved in sodium hydroxide (Nestmann *et al.*, 1979); this result parallels those reported with soluble chromium[VI] compounds in *polA*⁻ strains. It was equally toxic in WP2 and in CM871 (*uvrA*⁻ *recA*⁻ *lexA*⁻), unless dissolved in NTA (Venier *et al.*, 1987). Lead chromate did not elicit the SOS response in *E. coli* PQ37, unless it was solubilized by NTA (Venier *et al.*, 1989).

Lead chromate reverted *E. coli* (*trp*⁻ → *trp*⁺), when assayed in a fluctuation test after preliminary solubilization in sodium hydroxide (Nestmann *et al.*, 1979) and in both the spot test and a fluctuation test when dissolved in NTA (Venier *et al.*, 1987). In the *his*⁻ → *his*⁺ reversion test in *S. typhimurium*, zinc chromate was active in aqueous medium, and its mutagenicity was increased in the presence of sodium hydroxide or NTA (Venier *et al.*, 1985b). Chromium orange was mutagenic when spotted directly on the centre of agar plates and also became active in the plate test when dissolved in sodium hydroxide (Petrilli & De Flora, 1978b; De Flora, 1981a) or in NTA (Venier *et al.*, 1985b; Loprieno *et al.*, 1985). Likewise, molybdenum orange was mutagenic when spotted in solid form and in the plate test when dissolved in sodium hydroxide (De Flora, 1981a). Barium chromate was inactive unless dissolved in NTA (Venier *et al.*, 1985b). Lead chromate, tested following solubilization in acid or alkali, was mutagenic to the same strains that are sensitive to soluble chromium[VI] compounds (Nestmann *et al.*, 1979; Petrilli & De Flora, 1982). When tested in aqueous suspension, it was not mutagenic, but mutagenic chromate was released when it was dissolved in sodium hydroxide or NTA (Loprieno *et al.*, 1985; Venier *et al.*, 1985b, 1987). Its inactivity in strain TA102 was unaffected by the presence of oil dispersants (De Flora *et al.*, 1985a). Highly insoluble chromium yellow was inactive even when spotted in solid form; it became mutagenic in the plate test only when dissolved in sodium hydroxide (De Flora, 1981a; Petrilli & De Flora, 1982). In the *gal*⁺/*gal*⁻ forward mutation test in strain K-12/343/113 (λ) of *E. coli*, lead chromate was inactive even when dissolved in sodium hydroxide (Nestmann *et al.*, 1979).

Lead chromate, dissolved in hydrochloric acid, induced mitotic recombination in strain D5 of *Saccharomyces cerevisiae*; the effect was decreased in the presence of rat liver post-mitochondrial supernatant (Nestmann *et al.*, 1979). It induced sex-linked recessive lethal mutations in *Drosophila melanogaster* only when dissolved in NTA (Costa *et al.*, 1988).

Alterations in the mitotic cycle were induced by the lead chromate-containing pigments, chromium orange, molybdenum orange and chromium yellow, in human epithelial-like heteroploid HEP-2 cells following a 48-h incubation in cell growth medium (Levis & Majone, 1981). Lead chromate, even when dissolved in sodium

hydroxide, did not induce DNA fragmentation in Chinese hamster CHO cells, as evaluated by alkaline sucrose gradient (Douglas *et al.*, 1980), and it was not mutagenic in these cells, as evaluated in both 6-thioguanine- and ouabain-resistant systems; it did not induce ouabain or 6-thioguanine resistance in mouse embryo C3H10T1/2 cells (Patierno *et al.*, 1988). In the *hprt* assay in Chinese hamster V79 cells, lead chromate gave negative results both for 8-azaguanine resistance (Newbold *et al.*, 1979) and 6-thioguanine resistance, unless it was dissolved in NTA (Cecchetti *et al.*, 1987).

In aqueous suspension, all of these poorly soluble chromium[VI] compounds induced sister chromatid exchange in mammalian cells (Table 26). In human peripheral blood lymphocytes, lead chromate also induced micronuclei, with an enhancing effect following addition of an equimolar concentration of NTA (Montaldi *et al.*, 1987b). Aqueous suspensions of lead chromate, of all three derived pigments and of zinc chromate were clastogenic in mammalian cells (Table 27).

Zinc chromate and lead chromate induced anchorage-independent growth of Chinese hamster BHK fibroblasts in the soft agar assay (Hansen & Stern, 1985). [See General Remarks, p. 44, for concern about this assay.] Only lead chromate (which was phagocytized) induced morphological transformation in mouse embryo C3H10T1/2 cells, which contrasted with the lack of transforming ability of potassium dichromate, calcium chromate and strontium chromate observed in the same study (Patierno *et al.*, 1988). Both lead chromate (Casto *et al.*, 1979; Hatch & Anderson, 1986) and zinc chromate (Casto *et al.*, 1979) enhanced viral transformation in Syrian hamster embryo primary cells.

Lead chromate increased the frequency of micronuclei in polychromatic erythrocytes and decreased the polychromatic/normochromatic erythrocyte ratio in bone-marrow cells of intraperitoneally treated C57Bl/6N mice (Watanabe *et al.*, 1985).

Chromyl chloride

Chromyl chloride [Cl_2CrO_2], a volatile liquid chromium[VI] compound, reverted *his*⁻ *S. typhimurium* in the plate test; its potency, the spectrum of sensitivity of bacterial strains and the attenuating effect of rat liver post-mitochondrial supernatant were similar to those seen for soluble chromium[VI] compounds. Moreover, as assessed by suitable modifications of the standard *Salmonella* test, its vapours were also mutagenic (De Flora *et al.*, 1980; De Flora, 1981a).

(iv) *Other chromium compounds*

The water-soluble chromium[II] salt, chromous chloride [CrCl_2], which readily oxidizes to chromium[III] in contact with air, induced infidelity of DNA synthesis, with poly[d(A-T)] as a template in the presence of avian myeloblastosis virus DNA polymerase (Sirover & Loeb, 1976). Chromium[II] was inactive, however, in

all assays with cellular systems, including production of DNA fragmentation in Novikoff ascites hepatoma cells (Wedrychowski *et al.*, 1986a), of chromosomal aberrations and sister chromatid exchange in Syrian hamster embryo primary cells (Tsu-da & Kato, 1977), and of aneuploidy in human skin fibroblasts (Nijs & Kirsch-Volders, 1986).

Chromium carbonyl $[\text{Cr}(\text{CO})_6]$, a hexacoordinated compound with oxidation state 0 (dissolved in ether due to its insolubility in water), was inactive in a differential killing test in *E. coli* (WP2 vs. WP67 and CM871) (De Flora *et al.*, 1984a) and in the reversion test in various *his*⁻ *S. typhimurium* strains (De Flora, 1981a; De Flora *et al.*, 1984a).

In contrast to a purple, anionic chromium[III]-glutathione complex, a green sodium chromium[V]-glutathione complex ($\text{Na}_4(\text{GSH})_4\text{Cr}(\text{V}) \cdot 8\text{H}_2\text{O}$) cleaved super-coiled DNA of the bacteriophage PM₂ (Kortenkamp *et al.*, 1989). Similarly, in contrast to chromium[VI] and [III], the chromium[V] complex *trans*-bis[2-ethyl-2-hydroxybutanoato(2-)]oxochromate[V] cleaved covalently closed, circular plasmid puc9 DNA. In addition, it reverted strain TA100 of *S. typhimurium* with a potency comparable to that of potassium dichromate (Farrell *et al.*, 1989).

3.3 Other relevant data in humans

(a) Absorption, distribution, excretion and metabolism

(i) Chromium[III] compounds

More than 99% of administered chromium was recovered in faeces following oral administration of chromic chloride to humans; about 94% was recovered after duodenal administration. In both cases, about 0.5% was excreted in urine (Donaldson & Barreras, 1966). After exposure to chromium[III] by inhalation, urinary concentrations of chromium were somewhat increased, indicating respiratory absorption (Aitio *et al.*, 1984; Foa *et al.*, 1988). Pulmonary uptake of chromium[III] is influenced by the nature of the compound; uptake and excretion of chromium[III] lignosulfonate dust by industrial workers was similar to that of water-soluble chromium[VI] (Kiilunen *et al.*, 1983). A study of tannery workers indicated two half-times — one in the order of hours, the other in the order of several days — for urinary excretion of chromium[III] (Aitio *et al.*, 1988).

After one volunteer had immersed his hand in tanning liquor for 1 h, monitoring of blood and urine for 24 h failed to detect dermal absorption of chromic sulfate (Aitio *et al.*, 1984). However, a fatal chromium intoxication, due to skin absorption, was described after accidental submersion of a worker in hot (70°C) chromic sulfate tanning liquor (Kelly *et al.*, 1982).

(ii) *Chromium[VI] compounds*

Following oral administration of sodium chromate in tracer doses to humans, faecal excretion of chromium indicated that about 10% of the administered dose had been absorbed from the gastrointestinal tract. After duodenal administration, approximately half of the administered radioactivity appeared to have been absorbed on the basis of faecal excretion, while 10% appeared in the urine during the first 24 h. Reduction of chromium[VI] to the trivalent form was demonstrated (Donaldson & Barreras, 1966). Circadian monitoring showed post-meal peaks of chromium[VI] reducing activity that may correspond to several tens of milligrams per day (De Flora *et al.*, 1987a).

Correlation between respiratory exposure to chromium[VI] and urinary excretion of chromium has been demonstrated in welders and in workers in the plating industry (Lindberg & Vesterberg, 1983; Aitio *et al.*, 1988). The respiratory uptake rate is unknown, but it depends on the solubility of the chromium compound (for review, see Aitio *et al.*, 1988). Chromium[VI] is reduced in the lower respiratory tract by the epithelial lining fluid and by pulmonary alveolar macrophages. At equivalent numbers of cells, the reducing efficiency of alveolar macrophages by biochemical mechanisms was significantly greater in smokers than in nonsmokers (Petrilli *et al.*, 1986c).

In contrast to chromium[III], which is bound to plasma proteins such as transferrin, chromium[VI] entering the blood stream is taken up selectively by erythrocytes, reduced, and bound predominantly to haemoglobin (Gray & Sterling, 1950; Aaseth *et al.*, 1982; Kitagawa *et al.*, 1988; see also the section on genetic and related effects). Reduction of chromium[VI] during transport in the blood is consistent with the finding that chromium is present in urine only in its reduced form (Mertz, 1969; Nomiya *et al.*, 1980).

Aitio *et al.* (1988) reviewed the results of biological monitoring of chromium exposure to estimate biological half-times for excretion; the most data were available for manual metal arc stainless-steel welders exposed to soluble chromium[VI]. Three half-times — 7 h, 15-30 days and three to five years — were identified. The best estimates for the sizes of the different compartments are 40%, 50% and 10%, respectively. Lindberg and Vesterberg (1983) also found a correlation between exposure and urinary excretion of chromium in platers.

Retention of chromium on the skin was observed following topical application of sodium chromate (Baranowska-Dutkiewicz, 1981).

(b) *Toxic effects*

In adults, the lethal oral dose of chromates is considered to be 50-70 mg/kg bw. The clinical features of acute poisoning are vomiting, diarrhoea, haemorrhagic diathesis and blood loss into the gastrointestinal tract, causing cardiovascular shock

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(Sharma *et al.*, 1978; World Health Organization, 1988). If the patient survives for more than about eight days, the major effects are liver necrosis and tubular necrosis of the kidneys (World Health Organization, 1988).

Chronic ulcers of the skin and acute irritative dermatitis have been reported consistently in workers exposed to chromium-containing materials (World Health Organization, 1988). Chromates and chromium[VI] released from alloys and chromium-plated objects have been associated with the induction of allergic contact dermatitis. It is generally assumed that chromium[VI] is necessary for the sensitization, while both chromium[VI] and chromium[III] may cause dermatitis in sensitized individuals (see review by Haines & Nieboer, 1988). Intracellular reduction of chromium[VI] to the trivalent form seems to be a prerequisite for the effect (Polak *et al.*, 1973). In a study conducted in Finland, 2% of men and 1.5% of women showed a positive patch-test reaction to potassium dichromate (Pelkonen & Fräki, 1983). Chromium ulcers and chromate dermatitis have been reported in people in numerous occupations that involve manual handling of products containing chromium (Pedersen, 1982; Burrows, 1983; Polak, 1983; Nieboer *et al.*, 1984). The role of chromium[III] compounds in causing skin ulcers and acute irritative dermatitis is unclear (World Health Organization, 1988).

Inhalation of chromium[VI] compounds may give rise to necrosis in the nasal septum, leading to perforation. Lindberg and Hedenstierna (1983) found nasal irritation in chrome plating workers exposed by inhalation to chromium trioxide ($> 1 \mu\text{g}/\text{m}^3 \text{Cr}$) and nasal perforation in two-thirds of workers with exposure to peak levels above $20 \mu\text{g}/\text{m}^3 \text{Cr}$. Decreased respiratory function has been reported in platers exposed to chromates (Bovet *et al.*, 1977; Lindberg & Hedenstierna, 1983). Similar effects have been observed in welders and ferrochromium workers, although the role of chromium is uncertain as such persons have mixed exposures (World Health Organization, 1988).

Bronchial asthma may occur as a result of inhalation of chromate dust or chromium trioxide fumes (Meyers, 1950). Asthma among chromium platers, welders and ferrochromium workers has been reported to be due to exposure to chromates, among other compounds (Haines & Nieboer, 1988).

Franchini *et al.* (1978) reported on the excretion of β -glucuronidase, protein and lysozyme in the urine of 99 workers exposed to chromium compounds. No abnormal level was found among 39 stainless-steel welders; eight of 36 workers using special electrodes when welding on armoured steel had increased urinary levels of β -glucuronidase, and three of these workers had proteinuria. Among 24 workers engaged in chrome plating, nine had increased β -glucuronidase levels and four had elevated levels of protein in urine. The increased excretion of enzymes found in these workers was corroborated by exposing rats to potassium dichromate by sub-

cutaneous injection (1.5 mg/kg bw as a single injection or 0.3 mg/kg bw every other day for two weeks); furthermore, a correlation between chromium in the renal cortex and an increase in chromium clearance was reported. Verschoor *et al.* (1988) investigated a number of parameters of kidney function in chrome platers, welders, boiler-makers and an unexposed reference group. Urinary chromium values ranged from 0.3 to 62 µg/g creatinine (0.1-2 µg/g among controls). Renal function was not related to urinary chromium or to chromium clearance, but chromium clearance was increased in the two groups with the highest exposure (platers and welders).

(c) *Effects on reproduction and prenatal toxicity*

In a review, Clarkson *et al.* (1985) found no report in the literature of an effect of any chromium compound on reproduction or prenatal development in humans.

(d) *Genetic and related effects*

The studies described below are summarized in Appendix 1 to this volume.

(i) *Chromium[III] compounds*

In a comparison of 17 healthy tannery workers with continuous exposure for 13.4 ± 8.2 years to chrome alum and 13 external employees matched for social status, age, sex and years of service, no increase in the frequency of chromosomal aberrations was seen (Hamamy *et al.*, 1987). Average chromium levels of exposed persons were 0.12 µg/l plasma and 0.14 µg/l urine; these values were not considered to be different from those of controls. The level of chromium in air ranged from 15 (day) to 47 (night) µg/m³. [The Working Group noted that exposure was estimated by correlation with a parallel study.] When the data were analysed according to smoking habit, workers who smoked had higher frequencies of chromosome-type aberrations per cell (0.035) than either nonsmoking workers (0.011; $p < 0.01$) or control smokers (0.016; $p < 0.05$). The authors commented that the values for controls were relatively high in comparison with those in other cytogenetic studies reported in the literature.

In the study described below, enhanced levels of chromosomal aberrations, correlated with exposure duration, were observed in workers exposed to 'chromoxide' (Bigaliev *et al.*, 1977a). [The Working Group was unclear whether or not this was a chromium[III] compound.]

(ii) *Chromium[VI] compounds*

Bigaliev *et al.* (1977a) examined peripheral lymphocytes from 132 workers in chromium production who were exposed to one of five chromium compounds and compared them with 37 healthy, unexposed workers. Significant increases in the

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frequency of chromosomal aberrations over control values of $1.88 \pm 0.74\%$ metaphases with aberrations were observed, as follows: monochromate (sodium chromate), with a dose-related trend (correlation with exposure duration) ranging from 3.6 to 8.2% aberrant metaphases; sodium chrompik (sodium dichromate), with a dose-related trend ranging from 4.5 to 5.7% aberrant metaphases; potassium dichromate, with a dose-related trend ranging from 3.6 to 9.0%; chromoxide (as reported in the preceding section), with a dose-related trend ranging from 4.5 to 7.2%; and chromanhydride (chromium trioxide), with a dose-effect trend ranging from 5.4 to 9.4%. [The Working Group noted that no information was provided on exposure levels or on selection criteria, but the overall sample size was large.] When chromosomal aberrations were examined in detail (Bigaliev *et al.*, 1977b,c; Bigaliev, 1981), increased frequencies were found for single and double fragments, for translocations and for aneuploidy, consisting mainly of chromosome loss. Dose-responses were observed overall, and for each type of damage. In a later study (Bigaliev *et al.*, 1979), elongated cell-cycle times were seen for cultured peripheral lymphocytes from a group of chromium workers with five or more years' exposure, compared with a control group registered at the city blood transfusion station. An effect of duration of exposure was reported in a further analysis (Bigaliev *et al.*, 1977c; Bigaliev, 1981).

Several studies have been carried out on chromium platers. Increased frequencies of sister chromatid exchange were found in a study of male chromium platers exposed to chromium trioxide fumes (Stella *et al.*, 1982). Mean sister chromatid exchange values of 8.08 ± 2.67 ($p < 0.001$) were observed in exposed workers *versus* 6.31 ± 1.56 in ten healthy male donors aged 20-35 who had not been exposed to ionizing radiation. The authors noted particularly that the seven youngest workers, although the most recently engaged in chromium plating, showed significantly increased sister chromatid exchange frequencies. An effect of age on the induction of sister chromatid exchange was noted in the control group. [The Working Group noted that details were not provided on exposure, or on confounding factors].

Sarto *et al.* (1982) analysed sister chromatid exchange and chromosomal aberrations in peripheral blood lymphocytes of chrome platers in four factories in the same region, grouped by type of exposure and factory: groups 1 (eight persons) and 2 (nine persons) used a 'bright plating' process and were exposed to chromium trioxide and nickel; groups 3 (12 persons) and 4 (nine persons) used a 'hard plating' process and were exposed only to chromium trioxide. Controls were 35 healthy male sanitary workers who had not been exposed to occupational or diagnostic ionizing radiation for at least five years and had not knowingly been exposed to either occupational mutagens or mutagenic drugs. Their mean ages and smoking habits were similar to those of the exposed workers. The average ages in the four exposed groups were 39, 42, 24 and 34 years, respectively; urinary chromium levels ($\mu\text{g/g}$

creatinine) in the four groups were 5.1 ± 1.8 , 7.1 ± 3.3 , 11.8 ± 8.7 and 6.8 ± 3.7 , respectively, *versus* 1.9 ± 1.4 for controls. Sister chromatid exchange frequencies in the 'hard plating' groups were increased ($p < 0.001$) from $6.60 \pm 0.80\%$ in controls to $8.30 \pm 1.80\%$; however, when the values were analysed by age, a significant increase in sister chromatid exchange was observed only in the group of younger workers (group 3). A correlation was observed between sister chromatid exchange frequency and both age and urinary chromium levels (more sister chromatid exchange in younger workers with higher levels of chromium). A significant increase in the frequency of chromosomal aberrations, mostly of the chromosome type, was observed, from 1.7% of metaphases in controls to 3.8 ($p < 0.001$) in 'bright' platers and 2.8 ($p < 0.01$) in 'hard' platers. Chromatid-type aberrations were observed only in the 'bright' platers. The correlation between urinary chromium levels and chromosomal aberrations was poor.

No increase in the frequency of sister chromatid exchange was observed in a group of 24 male chromium platers exposed to chromium in air for 0.5-30.5 (mean, 11.6 ± 7.5) years, when compared with a group of office workers matched for sex, age and smoking habit (Nagaya, 1986). Smokers and nonsmokers were analysed separately for each group, and a smoking-related increase in the frequency of sister chromatid exchange was observed for both exposed (smokers, $10.7 \pm 1.7\%$; nonsmokers, $9.0 \pm 1.0\%$) persons and controls (smokers, $10.6 \pm 2\%$; nonsmokers, $8.9 \pm 1.2\%$). No correlation was seen between sister chromatid exchange frequencies and urinary chromium levels ($13.1 \pm 16.7 \mu\text{g/l}$ for exposed persons, none detected for controls). In a further study of a larger group (Nagaya *et al.*, 1989), essentially the same results were obtained. The authors speculated that the chromium exposure may have been too low to affect circulating lymphocytes. [The Working Group noted that high control values were observed in both studies.]

Choi *et al.* (1987) compared two groups of metal platers, consisting of seven workers in chromium surface treatment (group 1) and 25 workers in chromium plating (group 2), with 15 non-plating workers matched for age, sex and length of career. Exposures to chromium in air and urine were 0.027 (0.021-0.034) mg/m^3 and $24.0 \pm 7.8 \mu\text{g/l}$, respectively, for group 1, and 0.008 (0.005-0.012) mg/m^3 and $15.2 \pm 5.9 \mu\text{g/l}$, respectively, for group 2. Sister chromatid exchange frequency was increased from 3.6 ± 1.5 (controls) to 6.9 ± 1.8 ($p < 0.05$) in group 1 and to 5.4 ± 2.1 ($p < 0.05$) in group 2. A dose-effect relationship was observed with urinary chromium levels ($p < 0.01$). No effect of smoking was observed in exposed workers or controls.

Deng *et al.* (1983, 1988) observed significant increases in the frequencies of sister chromatid exchange and of chromosomal aberrations (gaps, breaks, fragments; 5.7% *versus* 0.8% in controls) in lymphocytes of seven chromium platers. Details of the study are provided in the monograph on nickel and nickel compounds, p. 389.

Several studies of occupational exposures to chromium during welding are described in the monograph on welding, pp. 487-489. Both enhancement (Koshi *et al.*, 1984) and lack of enhancement (Husgafvel-Pursiainen *et al.*, 1982; Littorin *et al.*, 1983) of sister chromatid exchange and chromosomal aberrations were reported in exposed workers.

As reported in an abstract (Imreh & Radulescu, 1982), 18 workers in a bichromate producing plant with a mean duration of exposure of 21.3 years (19-26 years) showed significantly elevated frequencies of chromosomal and chromatid-type aberrations and micronuclei when compared with eight mechanics from the same plant and with 34 healthy external controls. Sister chromatid exchange frequencies were not significantly greater than in the mechanics.

3.4 Case reports and epidemiological studies of carcinogenicity to humans

Epidemiological studies on chromium have been reviewed extensively (see, e.g., Sunderman, 1976; Norseth, 1980; Anon., 1981; Norseth, 1981; Sunderman, 1984, 1986; Adachi & Takemoto, 1987; Fan & Harding-Barlow, 1987; Hayes, 1988; World Health Organization, 1988; Yassi & Nieboer, 1988). Epidemiological studies on welders exposed to chromium and its compounds are summarized in the monograph on welding (see pp. 489-505).

Epidemiological studies of cancer in workers in industries in which exposure to chromium compounds could occur are summarized in Tables 28-31. Standardized mortality ratios (SMRs) and confidence intervals (CIs), assuming Poisson distribution, are given in square brackets when they were calculated by the Working Group.

(a) Chromate production

(i) Case reports

Many case reports of lung cancer have been published in relation to work in chromate production. Many of these were reviewed by a Working Group for the IARC (1980a); further case reports were made by Pfeil (1935), Alwens and Jonas (1938), Zober (1979), Hyodo *et al.* (1980), Abe *et al.* (1982), Tsuneta (1982) and Nishiyama *et al.* (1985, 1988). After having seen five cases of gastrointestinal cancer among 44 deceased chromate workers, Teleky (1936) drew attention to the possibility that chromate exposure could also be associated with an increased risk for cancer of the gastrointestinal tract.

(ii) Epidemiological studies

The Working Group considered six studies covering several partially overlapping populations in seven plants producing chromate from chemical-grade chromite ore (Brinton *et al.*, 1952) in the USA; the degree of overlap could not be ascertained.

Table 28. Epidemiological studies of cancer in workers in chromate-producing industries

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
Seven US chromate plants; active employees 1930–47; 193 deaths	Male oil refinery workers, 1933–38	Respiratory system	42	20.7	Digestive system Oral region (also included in respiratory system)	13 3	2.0 5.4*	Machle & Gregorius (1948)
Seven US chromium plants; active employees 1940–50; 5522 person-years	US male white, non-white	Respiratory system, except larynx	10 white 16 non-white	14.3* 80.0*	Other sites	6 (whole cohort)	1.0 ns	Brinton <i>et al.</i> (1952); Gafafer (1953)
Health survey, 897 workers	Boston X-ray survey	Bronchogenic/lung	10	53.6 (prevalence ratio)				Gafafer (1953)
Three US plants; men employed 1937–40, surveyed 1941–60	Cancer mortality; US males 1950, 1953, 1958	Respiratory (160–164)	69 (2 maxillary sinus)	9.4*	Digestive system	16	1.5 ns	Taylor (1966); Enterline (1974)
290 cases near US chromium plant	Random sample of hospital admissions	Lung	11 ^a	∞				Baetjer (1950)
US chromate plant; employed one or more years 1931–37; all jobs related to exposure to soluble and insoluble chromium; lifetime exposure in months calculated	No independent comparison group	Lung	41					Mancuso & Hueper (1951); Mancuso (1975)

Table 28 (contd)

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
US chromate plant; 2101 (restricted to 1803) workers initially employed three or more months 1945-74; status 1977 (88.5% complete); population working in new and/or old production sites	Baltimore City; mortality	Lung	59	2.0*	Digestive system Other	13 14	0.60 0.40	Hayes <i>et al.</i> (1979)
Three UK chromate factories; men employed 1949-55	Cancer mortality, England and Wales	Lung	12	3.6*	All other sites	No increase		Bidstrup & Case (1956)
Same UK factories as studied by Bidstrup & Case (1956); 1948-77; 2715 males	Cancer mortality, England, Wales and Scotland	Lung	116	2.4*	Other sites Nasal cancer	80 2	1.2 ns 7.1*	Alderson <i>et al.</i> (1981)
Two FRG chromate plants; 1140 male workers employed more than one year 1934-79	Mortality, North Rhine Westphalen	Lung	51	2.1*	Stomach	12	0.94 ns	Korallus <i>et al.</i> (1982)
Tokyo chromium manufacture; 896 production workers, 1918-78	Age-, cause-specific mortality, Japanese males	Respiratory cancers	31 (6 sino-nasal)	9.2*	Stomach	11	1.0	Satoh <i>et al.</i> (1981)
		1-10 years' exposure	5	4.2*				
		11-20 years' exposure	9	7.5*				
		≥21 years' exposure	17	17.5*				

Table 28 (contd)

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
273 chromate producers in Japan; 1947-73; observed 1960-82	Age-, cause-specific mortality, Japanese males	Lung	25 (plus 1 maxillary sinus)	18.3*	Digestive system	6	0.9	Watanabe & Fukuchi (1984)
540 Italian chromate producers employed 10 years or more, 1948-85	Italian cause-specific death rates	Lung	14	2.2*	Larynx	3	2.9	De Marco <i>et al.</i> (1988)
		Highly exposed	6	4.2*	Pleura	3	30*	

^aIn comparison with internal reference population

*Significant at 95% level

ns Nonsignificant

Table 29. Epidemiological studies of cancer in workers in chromate-pigment industries

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
Norwegian chromium pigment production since 1948; 133 workers of whom 24 over 3 years' employment to 1972	Cancer incidence, Norway 1955-76	Lung	6 (one case with < 3 years' employment)	44 67 (10 years' latency)	Gastrointestinal Nasal cavity	3 1	6.4 -	Langård & Norseth (1975, 1979); Langård & Vigander (1983)
UK chromate pigment factories: A, lead & zinc chromate; B, lead & zinc chromate; C, lead chromate; followed up to 1981	Mortality, England and Wales	Lung						Davies (1978, 1979, 1984a)
		A (1932-54)	21	2.2*				
		B (1948-67)	11	4.4*				
		C (1946-60)	7	1.1 ns				
French lead and zinc chromate manufacturers; 251 males employed 6 months or more, 1958-77	Standard death rates, northern France 1958-77	Lung	11	4.6*				Haguenoer <i>et al.</i> (1981)
German and Dutch manufacturers of zinc and lead chromates; 978 workers followed up for 15 076 person-years	Local death rates, FRG and the Netherlands	Lung	19	2.0*				Frentzel-Beyme (1983)

Table 29 (contd)

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
US lead and zinc chromate production workers employed ≥ 1 month 1940–69; 1181 white, 698 non-white; followed up to end of 1982	Mortality, US whites and non-whites	Lung	24	1.4 ns	Stomach	6	1.8 ns	Sheffet <i>et al.</i> (1982); Hayes <i>et al.</i> (1989)
		(30-year latency)	3	1.4**				
		< 1 year exposure	3	2.0**				
		1–9 years' exposure	6	3.2**				
		≥ 10 years' exposure						

** p for trend < 0.01

ns Nonsignificant

Table 30. Epidemiological studies of cancer in workers in chromium-plating industries

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
54 UK chromium-plating plants; 1056 male platers	1099 non-exposed males in plants and in two nonplating industries	Lung	24	1.4 ns	All sites	44	1.7*	Royle (1975a,b)
					Gastrointestinal	8	1.5 ns	
					Other sites	12	1.9 ns	
Japanese chromium platers; 952 workers with > 6 months' exposure	Platers not exposed to chromium and clerical workers	Lung	0	-	All sites	5	0.5 ns	Okubo & Tsuchiya (1977, 1979, 1987)
US workers in diecasting and Ni-Cr-plating plant, 1974-78	US national mortality statistics	Lung men	28	1.9*	Stomach	4	2.5 ns	Silverstein <i>et al.</i> (1981)
		women	10	3.7*	Larynx	2	3.3 ns	
					Lymphosarcoma	2	2.9 ns	
Nine plants, Parma, Italy, 116 'thick' and 62 'thin' platers; employed more than 1 year 1951-81	Mortality, Italy	Lung	3	3.3* (4.3* for 'thick' platers)	All sites	8	1.9	Franchini <i>et al.</i> (1983)
UK chromium platers; 2689 (1288 men, 1401 women) first employed 1946-75; observed 1946-83	Mortality, England and Wales	Lung men	63	1.6*	Stomach (men and women)	25	1.5 ns	Sorahan <i>et al.</i> (1987)
		women	9	1.1 ns	Liver men	4	6.7*	
		Nasal cavity (men and women)	3	10*	women	0	-	
		Larynx men	3	3.0 ns				
		women	0	-				

* Significant at 95% level

ns Nonsignificant

Table 31. Epidemiological studies of cancer in workers in ferrochromium industries

Study population	Reference population	Cancer of respiratory organs			Cancer at other sites			Reference
		Site	Number	Estimated relative risk	Site	Number	Estimated relative risk	
USSR ferrochromium alloy industry; 1955–69	Mortality, general population of municipality	Lung (men)	Not given	4.4–6.6* by age	All sites (men)	Not given	0.5–3.3*	Pokrovskaya & Shabynina (1973)
					Oesophagus (men)	Not given	2.0*–11.3*	
Swedish ferrochromium plant; ferroalloy; 1876 workers for 1 or more years 1930–75; traced by parish lists and cancer registry	County or national statistics; classification of work areas by Cr[III] and Cr[VI]	Lung			Prostate (all workers)	23	1.2 ns	Axelsson <i>et al.</i> (1980)
		All workers	7	1.2 ns				
		Maintenance workers	4 (2 mesotheliomas)	4.0*				
		Arc workers	2 (1 mesothelioma)	1.0 ns				
Norwegian ferrochromium and ferro-silicon; 1235 male workers employed 1928–65	General population; internal comparison with unexposed	Lung	10	1.5 ns	All sites	132	0.8 ns	Langård <i>et al.</i> (1980, 1989)
		(ferrochromium workers)			Kidney	5	2.7 ns	
					Prostate	12	1.5 ns	
					Stomach (ferrochromium workers)	7	1.4 ns	

*Significant at 95% level

ns, Nonsignificant

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Machle and Gregorius (1948) reported high proportionate mortality from respiratory cancer among male workers at the seven chromate-producing plants in the USA: between 1930 and 1947, the annual death rate from respiratory cancer was 2.63/1000, as compared with a frequency of 0.09/1000 in a comparison group from an oil refinery in 1933-38. [The Working Group noted that the age structures of the two populations were not given.]

Brinton *et al.* (1952) and Gafafer (1953) conducted a mortality study (a US Public Health Service study) of male workers in the seven chromate manufacturing plants during 1940-50 with 5522 person-years of membership in sick-benefit associations for persons 15-74 years old, not including workers who had terminated employment with the chromate industry and those who had died more than one year after the onset of disability. Comparison was made to age- and race-specific US male mortality rates during 1940-48. Ten deaths from cancer of the respiratory system (except larynx) were observed among white employees (SMR, 1429 [95% CI, 685-2627]). Among non-white employees, 16 deaths from cancer at this site were found (SMR, 8000 [95% CI, 4573-12 991]). For the entire study group, six deaths from cancers at all other sites were observed [SMR, 95.2; 95% CI, 35-207]. [The Working Group noted that the SMR for lung cancer may have been biased, because of the exclusion of terminated and retired workers and of those who did not belong to the sick-benefit plan.] A health survey of 897 workers gave a prevalence ratio of 53.6 for bronchogenic cancer in chromate workers compared to persons who had undergone a chest X-ray survey for lung cancer (Gafafer, 1953).

Enterline (1974) reanalysed data from a study by Taylor (1966) of 1212 male workers who had been employed in three of the US plants for three months or longer for the period 1937-60. The study cohort, constructed from earnings reports in old age and survivors disability insurance records, was restricted to men born after 1889. Vital status was ascertained through 1960 by searching the death claim files of the records; death certificates were subsequently obtained for workers for whom death claims had been filed. Age-specific mortality figures for US males in the calendar years 1950, 1953 and 1958 were used as reference. A total of 69 deaths from cancers of the respiratory system (ICD codes 160-164) was observed (SMR, 943 [95% CI, 733-1193]), two of which were from maxillary sinus cancer; the author regarded this rate as greatly elevated. Furthermore, a small excess of deaths from cancer of the digestive system was observed (16 deaths; SMR, 153 [95% CI, 88-249]).

In a study of medical records from two hospitals in Baltimore, MD, USA, near a chromate-producing plant, Baetjer (1950) found that 11 (3.8%) of 290 male lung cancer patients admitted in 1925-48 had had exposure to chromates, whereas no chromate-exposed worker was found among a 'random' sample of 725 other hospital admissions. Ten of the 11 cases had worked in the local chromate production

plant and one in an electrical company. Occupational history was derived only from records.

Mancuso (1975) reported on a cohort recruited from a US chromate-producing plant that had been investigated earlier (Mancuso & Hueper, 1951). In the earlier report, six lung cancer deaths were observed, giving a relative risk of 15; using hygiene data collected in 1949, cumulative exposures to soluble, insoluble and total chromium, combined with length of exposure, were computed for each worker in the cohort. The second analysis was confined to the 41 deaths from lung cancer that occurred in persons first employed between 1931 when the plant started operation and 1937 and followed through 1974, and rates were computed using direct standardization, with the entire plant population as the standard. Mortality from lung cancer was associated with cumulative exposure to insoluble chromium, to soluble chromium and to total chromium. [The Working Group noted that the three classes of exposure were highly correlated and the risks of exposure to soluble and insoluble chromium could not be distinguished.]

Hayes *et al.* (1979) studied workers at a chromate production plant in Baltimore, MD, USA, which had been partly renovated in 1950-51 and 1960 to reduce exposure to chromium dusts. The study cohort consisted of 2101 workers with more than 90 days of work experience, first employed between 1945 and 1974, and followed through July 1977; vital status was ascertained for 75% on an individual basis and for another 14% on a group basis. SMRs for 1803 hourly employees were calculated on the basis of expected values derived from the age-, race- and time-specific mortality rates for Baltimore City males. There were 404 deaths from all causes (SMR, 92). The overall SMR for cancer of the trachea, bronchus and lung (ICD code 162) was 202, based on 59 observed deaths (95% CI, 155-263). Workers hired between 1945 and 1949, before the plant was renovated, who had been employed for fewer than three years, had an SMR for lung cancer of 180 (95% CI, 110-270), based on 20 observed deaths, whereas workers with three or more years of employment hired in that period had an SMR of 300 (95% CI, 160-520), based on 13 observed deaths. For workers hired in 1950-59, when part of the plant had better environmental controls, similarly elevated risks were seen, based on 12 and nine cases for short-term and long-term employment, respectively. No case of lung cancer was detected in 1960-74 after the plant had been renovated, but, as the authors noted, the latent period is too short for an adequate assessment of risk for cancer at this site. Additional case-control analyses were performed to determine whether specific work areas were associated with lung cancer hazard. Controls who had died from causes other than cancer were matched individually by race, date of hire, age at initial employment and duration of employment to the 66 hourly or salaried employees who had died from lung cancer. A significant ($p < 0.05$) elevation in risk for lung cancer was found for employees who had worked in the 'special products' and dich-

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romate areas, where soluble chromium[VI] compounds were produced and packaged (relative risks, 2.6 and 3.3, respectively).

On the basis of data from the previous study and the results of 555 air samples analysed in 1945-50, Braver *et al.* (1985) studied the relationship between exposure to chromium[VI] and occurrence of lung cancer. The authors reported a dose-response relationship with cumulative exposure. [The Working Group noted that the association appeared to be due predominantly to duration of exposure and not to estimated level of exposure, which did not vary substantially.]

A total of 723 chromate production workers from three factories in the UK who were interviewed and radiographed were followed up in 1949-55 by Bidstrup and Case (1956), who reported significantly higher than expected lung cancer mortality: 12 deaths [SMR, 364; 95% CI, 188-635] (based on age-adjusted rates for England and Wales). The average duration of exposure was 12.2 years; 165 (22.8%) persons had worked for more than 20 years (Bidstrup, 1951). For cancers at other sites, the observed and expected numbers of deaths did not differ significantly.

Alderson *et al.* (1981) studied 2715 chromate production workers with more than one year of work experience between 1948 and 1977 and who had undergone at least one X-ray of the lungs, 79 (2.9%) of whom were lost to follow-up, at the same three UK factories studied by Bidstrup and Case (1956). The percentage of heavy smokers was reported to be lower among the workers than among males in England and Wales [numbers not given]. During the study period, 602 deaths occurred (SMR, 135 [95% CI, 125-146]), 116 of which were from lung cancer (SMR, 242 [95% CI, 200-290]). Two deaths from nasal cancer were observed in one factory; 0.28 would have been expected for the whole cohort (SMR, 714 [95% CI, 87-2580]).

Korallus *et al.* (1982) identified 1140 workers who had been employed for one year or more at two chromate-producing plants in the Federal Republic of Germany. The study subjects were active workers and pensioners who had been hired before 1948 or workers hired thereafter. Vital status was ascertained from personnel documents and from population registries until 1979. Cause of death was determined from medical records and, in some cases, from death certificates. The SMR for respiratory cancer (ICD 8, 160-163) was 210 [95% CI, 156-276]. A total of 20 deaths from bronchial carcinomas (and one laryngeal carcinoma) was seen in one factory (SMR, 192 [95% CI, 119-294], and 30 deaths, all from bronchial carcinoma, in the second (SMR, 224 [95% CI, 151-319]). The author noted difficulties in the ascertainment of cause of death and of comparability with the standard population.

Satoh *et al.* (1981) studied 896 men who had been engaged in manufacturing chromium compounds for one or more years in a factory in the Tokyo, Japan, area between 1918 and 1975. The workers were observed from 1918 through 1978 or to death; vital status could not be ascertained for an additional 165 retired workers. The authors stated that 84% of the chromium compounds manufactured between

1934 and 1975 were hexavalent compounds and 16% trivalent compounds. The expected numbers of deaths were based on age- and cause-specific mortality rates for Japanese males. Between 1950 and 1978, 120 deaths (SMR, 90) were observed, 31 of which were from respiratory cancer [SMR, 923; 95% CI, 627-1310]; 25 of these were from lung cancer and six from sinonasal cancer. No other cancer occurred in excess. When the population was subdivided by duration of work, there were five cases of respiratory cancer in the group with one to ten years of exposure [SMR, 423; 95% CI, 138-989], nine in the group with 11-20 years' exposure [SMR, 748; 95% CI, 343-1424] and 17 in the group with more than 21 years of exposure [SMR, 1747; 95% CI, 1021-2806].

Watanabe and Fukuchi (1984) reported in an abstract a mortality study of 273 workers employed in 1947 or later at a chromate-producing factory in Japan for at least five years until 1973, previously studied by Ohsaki *et al.* (1974, 1978). The population was observed from January 1960 to December 1982. Expected numbers of deaths were based on age-, year- and cause-specific death rates for the Japanese male population. Sixty deaths from all causes were observed; 33 from all cancers, of which 25 were from lung cancer (SMR, 1832 [95% CI, 1190-2714]) and six from cancer of the digestive organs [SMR, 88; 95% CI, 32-192]; one cancer of the maxillary sinus was seen.

In an Italian cohort study of 981 chromate production workers employed for one year or more in 1948-85 (De Marco *et al.*, 1988), analysis was limited to the 540 workers followed up for ten years or more. Cause-specific death rates in Italy were used as a reference level. The SMR for lung cancer was 217 (14 deaths; 95% CI, 118-363), and there were three deaths each from cancers of the pleura and larynx. Among a subgroup of workers with heavy exposure to hexavalent chromium compounds (on the basis of job histories), the SMR for lung cancer was 420 (six deaths [95% CI, 154-193]).

(b) *Production of chromate pigments*

(i) *Case reports*

Newman (1890) reported the first case of cancer in a 'chrome worker', which was an adenocarcinoma of the anterior half of the left nostril in a 47-year-old male worker who had had perforation of his nasal septum for 20 years; the patient had been exposed to chrome pigments. Since that time, there have been a number of case reports of lung cancer in workers involved in production of chromate pigments (Gross & Kölsch, 1943; Letterer *et al.*, 1944; Langård & Kommedal, 1975; Zober, 1979; Rivolta *et al.*, 1982).

(ii) *Epidemiological studies*

Langård and Vigander (1983) followed up 133 workers for 1953-80, who had been employed in a small Norwegian company producing chromate pigments in

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1948-72, previously studied by Langård and Norseth (1975). The work force was exposed to zinc chromate from 1951; a small number of workers had also been exposed to lead chromate between 1948 and 1956. While past levels of exposure to hexavalent chromium are unknown, exposures to chromates as chromium measured in 1973 ranged from 0.01 to 1.35 mg/m³ (Langård & Norseth, 1979). One case of lung cancer occurred among 109 workers with less than three years of employment prior to 1972. Six cases of lung cancer occurred in a subpopulation of 24 workers with more than three years of work experience prior to 1972 [giving a standardized incidence ratio (SIR) of 4444 (95% CI, 1631-9674) on the basis of national incidence rates among males]. More than ten years after first exposure, the SIR was 6667 [95% CI, 2447-14 510] on the basis of national reference rates. Only 18 workers had worked at the plant for more than five years, and all six cases belonged to this subgroup. One of the cases had worked in the production of zinc chromate as well as lead chromate, while five cases had worked in the production of zinc chromate only. A previous follow-up had found one case of cancer of the nasal cavity, one of cancer of the prostate and three of cancer of the gastrointestinal tract (one cancer of the pancreas, one stomach cancer and one cancer of the large intestine) (Langård & Norseth, 1979). The three latter cases occurred in the subgroup of 24 workers employed for more than three years before 1972 [SMR, 638; 95% CI, 0.6-8.8].

Davies (1978, 1979, 1984a) studied mortality among 1002 male workers at three factories in the UK where chromate pigments were manufactured. Production of lead chromate[VI] occurred in all factories; workers in two of the factories (A and B) were additionally involved in manufacturing zinc chromate[VI] until 1964 and 1976, respectively. Small amounts of barium chromate were produced in factory A from 1942, and small amounts of strontium chromate were produced in factory B from the early 1950s to 1968. Factory A closed in 1982 and factory B in 1978. Exposure levels were classified only as high, medium or low. The 1984 report extended the follow-up from the 1930s or 1940s to the end of 1981. The expected numbers were based on calendar time period-, sex- and age-specific mortality rates for England and Wales. An excess of lung cancer appeared in two groups of workers assigned to high and medium exposure: factory A, those entering before 1955 (21 cases; SMR, 222 [95% CI, 138-340]) and factory B, those entering before 1968 (11 cases; SMR, 440 [95% CI, 220-787]). In workers with low exposure to zinc and lead chromates in factories A and B, seven lung cancer deaths were observed [SMR, 101; 95% CI, 41-208]. In factory C, where only lead chromate was produced, seven lung cancer deaths were observed [SMR, 109; 95% CI, 44-224], and the highest ratio was found for one to 29 years of follow-up of a group of 33 men among early entrants with high and medium exposure (three cases [SMR, 357; 95% CI, 74-1044]). The author indicated that moderate or heavy exposure to zinc chromate may give rise to

a high risk for developing lung cancer, and that relatively mild or short-term exposure may not constitute a measurable lung cancer hazard.

Davies (1984b) also studied a subgroup of 57 workers involved in the production of lead chromate pigments from lead nitrate in the same three factories, who had been reported to the work inspectorate to have lead poisoning, mostly between 1930 and 1945. Mortality was observed through 1981, giving 1585 person-years of observation. Four deaths from lung cancer (SMR, 145 [95% CI, 40-370]) were observed. [The Working Group noted that this small sample of workers might have been highly selected.]

Haguenoer *et al.* (1981) reported deaths among a cohort of 251 workers in a factory manufacturing zinc and lead chromate pigments in France who had been employed for more than six months between 1 January 1958 and 31 December 1977. Fifty deaths occurred, the specific cause of which was known from medical records for 30. Expected numbers were derived from death certificates. Among the 30 deaths, there were 11 confirmed lung cancer deaths (SMR, 461; 95% CI, 270-790). The mean time from first employment until detection of cancer was 17 years, and the mean duration of employment among cases was 15.3 years. [The Working Group noted that cause of death was ascertained from different sources for observed and expected cases.]

Frentzel-Beyme (1983) studied mortality among men employed for more than six months in three factories in the Federal Republic of Germany and two factories in the Netherlands that produced lead and zinc chromate pigments. The total number of study participants was 1396. Regional death rates in the two countries were used to estimate expected figures. In an analysis of 978 men with exposure beginning before 1965, 117 deaths were observed [SMR, 96], of which 19 were from lung cancer [SMR, 204; 95% CI, 123-319].

Hayes *et al.* (1989) followed-up a cohort studied by Sheffet *et al.* (1982) consisting of 1879 male employees of a New Jersey (USA) lead and zinc chromate pigment production factory who had been employed for at least one month between January 1940 and December 1969; they were observed from 1940 to 1982. US age- and calendar-specific death rates for white and nonwhite men were used as reference. Vital status was ascertained for 1737 workers (92%). Airborne chromium concentrations were measured during later years, giving estimates of > 0.5 mg/m³ for exposed jobs and of > 2 mg/m³ for highly exposed jobs; the ratio of lead chromate:zinc chromate in the working atmosphere was reported to be about 9:1, and low levels of nickel may have been present. The SMR for all cancers was 93 (101 deaths; 95% CI, 76-113). Among a total of 41 lung cancer deaths (SMR, 116; 95% CI, 83-158), 24 occurred among workers exposed to chromate dusts (SMR, 143). The SMR for lung cancer among men who had not worked in chromium-exposed jobs was 92 (17 deaths; 95% CI, 53-147), and that for men who had worked for less than one year was 93 (seven

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deaths; 95% CI, 37-192). For those with cumulative exposure to chromate dusts of one to nine years, the SMR was 176 (nine deaths; 95% CI, 80-334), and for ten or more years, 194 (eight deaths; 95% CI, 83-383). When accounting for 30 years since first employment among men with more than ten years' exposure, the SMR rose to 321 (95% CI, 117-698), based on six cases. In jobs with exposure to chromate dusts, a nonsignificant excess of cancer of the digestive tract was found; for stomach cancer, the SMRs were 149, 185 and 214 for those with less than one, one to nine and more than ten years' exposure, respectively.

(c) *Chromium plating*

(i) *Case reports*

Cases of lung cancer have also been reported among chromium platers (Barbořík *et al.*, 1958; Kleisbauer *et al.*, 1972; Korallus *et al.*, 1974b,c; Michel-Briand & Simonin, 1977; Takemoto *et al.*, 1977; Sano, 1978; Zober, 1979; Brochard *et al.*, 1983; Kim *et al.*, 1985).

(ii) *Epidemiological studies*

Royle (1975b) conducted a mortality study among past and current workers with three months or more of consecutive employment in 54 chromium-plating plants in Yorkshire, UK. The study covered 1238 chromium-plating workers (1056 men, 182 women), 142 of whom had died by 31 May 1974. A control population of 1284 manual workers (1099 men, 185 women) was drawn from non-chromium-plating departments of the largest firms and from the past and current work force of two industrial companies located in the same geographic region. The control subjects were matched individually to the platers by sex, age, date when last known to be alive and, for current workers, smoking habits. The study population represented 91% of the total exposed population and 93% of the eligible controls. Compared with the controls, chromium platers experienced a significant excess proportion of deaths from total cancer: 51/142 *versus* 24/104 in men and women combined ($p < 0.01$). The excess was statistically significant only for individuals who had been platers for more than one year. In male chromium platers, 24 lung cancer deaths (ICD codes 162, 163) out of a total of 130 deaths were observed *versus* 13/96 among controls (nonsignificant). Cancer of the gastrointestinal tract and of 'all other sites' also occurred in excess in men, but the differences were not significant: 8/130 deaths from gastrointestinal cancers among exposed *versus* 4/96 in controls; 12/130 deaths from cancers of 'all other sites' in exposed *versus* 5/96 in controls. The smoking habits of platers and controls were similar. A higher proportion of controls had worked in asbestos processing (8.3% of controls *versus* 3.6% of platers); more platers had worked in coal mines, foundries, potteries, cotton manufacture and flax and hemp mills (Royle, 1975a). [The Working Group noted that past exposure to asbestos among the controls might have led to some underestimation of the lung cancer risk

in the exposed group, and that the method of analysis used made the study difficult to interpret.]

Okubo and Tsuchiya (1977, 1979) reported results from a mortality study among 952 chromium platers in Tokyo, Japan. The cohort was constructed from records for 1970-76 of the Tokyo Health Insurance Society of the Plating Industry, and consisted of chromium platers (889 men, 63 women) who were born prior to 31 May 1937, had more than six months of work experience in chromium plating and had a work history record. Vital status was ascertained from a questionnaire sent to the management of the plating firms and, for retired workers, by contacting family registers; persons whose vital status was unknown were assumed to be alive. The expected number of deaths was derived from age-, sex- and year-specific death rates for the Tokyo general population. Twenty-one deaths from all causes were observed in chromium platers [SMR, 55; 95% CI, 34-83]. No case of lung cancer occurred, although 1.2 would have been expected in men. These results were reiterated in a 99% follow-up of a subgroup reported in an abstract (Okubo & Tsuchiya, 1987). [The Working Group questioned the completeness of assembling the cohort, the low age structure of the population and the limited period of follow-up.]

Silverstein *et al.* (1981) performed a proportionate mortality study in a group of hourly employees and retirees with at least ten years of service in a die-casting and nickel- and chromium-electroplating plant in the USA. The 238 subjects who had died between January 1974 and December 1978 were included in the study. Causes of death as stated on death certificates were compared with US national mortality rates. A total of 53 deaths from cancer were observed (proportionate mortality ratio (PMR), 135 [95% CI, 101-176]) among white men and 23 among white women (PMR, 127 [95% CI, 81-191]). The study revealed 28 lung cancer deaths (PMR, 191 [95% CI, 127-276]) in white men and ten among white women (PMR, 370 [95% CI, 178-681]). Smoking habits were not known. Four deaths from stomach cancer (PMR, 254 [95% CI, 69-648]), two from laryngeal cancer (PMR, 330 [95% CI, 40-1184] and two from lymphosarcoma and reticulosarcoma (PMR, 285 [95% CI, 35-1032]) occurred in white men. A case-control analysis of the lung cancer deaths, using deaths from cardiovascular disease as controls, tested the association of cancer with duration of work in different work sites, without considering possible confounders. An association was seen (odds ratio, 9.2; $p = 0.04$) for white men with more than five years' work in a department which, prior to 1971, was one of the major die-casting and plating areas in the plant. The authors noted that, although the population had been exposed primarily to chromium[VI], they had also been exposed to nickel compounds and may have been exposed to polycyclic aromatic hydrocarbons and metal fumes during die-casting.

Franchini *et al.* (1983) reported cancer mortality in a group of 178 Italian chromium electroplaters, 62 of whom were 'bright' (thin plating) and 116 of whom were

'hard' (thick plating) platers, and who had worked for at least one year in one of nine plants between 1951 and 1981. In 1980, exposure to chromium averaged $7 \mu\text{g}/\text{m}^3$ air as chromium trioxide near the plating baths and $3 \mu\text{g}/\text{m}^3$ in the middle of the room; measurements of urinary chromium showed that hard platers were more heavily exposed than bright platers: the median level of chromium in the urine of hard platers was $23.1 \mu\text{g}/\text{g}$ creatinine in 1974-76 and $5.7 \mu\text{g}/\text{g}$ creatinine in 1980-81. The SMR for deaths from all causes was 97 (15 deaths [95% CI, 55-163]); there were eight deaths from malignant tumours (SMR, 191; [95% CI, 82-375]) and three from lung cancer [SMR, 333; 95% CI, 69-974]. Seven of the cancer deaths occurred among hard platers [SMR, 259; 95% CI, 105-534] as did all three of the lung cancers [SMR, 429; 95% CI, 88-1252].

Sorahan *et al.* (1987) reported the mortality experience of 2689 chromium platers (1288 men, 1401 women) in the UK observed from January 1946 to December 1983 who were involved mainly in 'bright' (thin) plating of bumpers and overriders, initially reported by Waterhouse (1975). Scattered sampling of exposure had taken place before 1973, showing air concentrations of chromium trioxide up to $8.0 \text{ mg}/\text{m}^3$, while the median values were 'nondetectable' or 'trace'; after 1973, measurements generally showed levels of chromium below $50 \mu\text{g}/\text{m}^3$. The cohort comprised workers employed in 1946-75 with more than six months' employment as a (chromium) electroplater. Death rates were compared with those of the general population of England and Wales. All members of the cohort had had at least some exposure to chromium but also some exposure to nickel chloride and nickel sulfate. A total of 213 cancer deaths (SMR, 130 [95% CI, 113-148]) and 72 lung cancer deaths (SMR, 150 [95% CI, 117-189]) were observed in men and women combined; 63 lung cancer deaths occurred in men (SMR, 158 [95% CI, 121-202]) and nine in women (SMR, 111 [95% CI, 46-261]). When the figures for each sex were combined and account was taken of time from first employment, the highest SMRs were 342 [95% CI, 182-585] after ten to 14 years and 245 [95% CI, 127-428] after 15-19 years of work at the chromium baths. Overall, three deaths (two in men, one in women) from cancer of the nose and nasal cavities occurred (SMR, 1000 [95% CI, 206-2922]); all three persons had been exposed to chromium for one to two years, while the third had also worked for 13 years plating nickel. There were 25 deaths from stomach cancer (SMR, 154 [95% CI, 100-228]), but this excess occurred only in men. Four deaths from cancer of the liver were observed in men (SMR, 667 [95% CI, 182-1707]) but none in women. In an analysis of data on first job held, the SMR for lung cancer was 199 (46 deaths [95% CI, 146-266]) for men first employed as chrome bath workers and 101 (17 deaths [95% CI, 59-161]) for chromium workers who were first employed at other work sites. The authors reported that only 11% of workers had had periods of work at both the chrome baths and other chrome work. Although a

significant association was found between work at chrome baths and death from lung cancer, no such association was found with work at nickel baths (Burgess, 1980).

In a case-control study in Denmark of 326 cases of laryngeal cancer and 1134 controls (Olsen & Sabroe, 1984), two of the cases occurred among male chromium platers, yielding a standardized incidence odds ratio of 110 (95% CI, 30-360).

(d) *Production of ferrochromium alloys*

Pokrovskaya and Shabynina (1973) studied a cohort of male and female factory workers engaged in chromium ferroalloy production between 1955 and 1969 in the USSR. Workers were reported to be exposed to chromium[VI] and chromium[III] compounds as well as benzo[a]pyrene. Death certificates were obtained from the municipal vital statistics office, and comparison was made with city mortality rates by sex and by ten-year age group. Access to complete work histories made it possible to exclude from the control cohort subjects who had been exposed to chromium in other plants. Male chromium workers aged 50-59 experienced significant [$p = 0.001$] increases in death rates from all malignancies, from lung cancer and from oesophageal cancer, as compared with deaths rates in the municipal population. The relative risk for lung cancer in men was reported to range from 4.4 in the 30-39-year age group to 6.6 ($p = 0.001$) in the 50-59-year age group. A large proportion of the cases of lung cancer among workers exposed to high concentrations of dust (cinder pit workers, metal crushers, smelter workers), including workers who were not exposed to benzo[a]pyrene in areas of furnace charge and finished products preparation. [The Working Group noted that the numbers of workers and the numbers of cancers by specific site were not reported.]

Axelsson *et al.* (1980) studied employees at a ferrochromium plant in Sweden producing ferrochromium alloys by furnace reduction of chromite ore, quartz, lime and coke; the study was restricted to all 1876 men employed for at least one year during the period 1 January 1930 to 31 December 1975 and alive in 1951. Records were available for all employees who had worked since 1913. Individuals were categorized according to length and place of work in the factory. Death certificates (1951-75) were obtained from the national Central Bureau of Statistics and incident cancer cases (1958-75) from a manual search of Cancer Registry files. Expected numbers of cancer deaths and incident cases were calculated assuming a 15-year latent period from onset of employment. The estimated levels of chromium metal plus chromium[III] in the work atmosphere ranged from 0 to 2.5 mg/m³, and those for chromium[VI] from 0 to 0.25 mg/m³. There were 87 cases of cancer in the period 1958-75 [SIR, 101; 95% CI, 81-125], of which seven were cancers of the trachea, bronchus, lung and pleura [SIR, 119; 95% CI, 48-245]. Among 641 arc furnace workers, who were considered as being most likely to have encountered exposure to chromium[III] and [VI], there were two cases of cancer at these sites [SIR, 95; 95%

CI, 12-344], one of which was a pleural mesothelioma. Among 326 maintenance workers, there were four cases of cancer at these sites [SIR, 400; 95% CI, 109-1024], two of which were mesotheliomas. Asbestos had been used in the factory.

Langård *et al.* (1980, 1990) studied male workers at a ferrochromium and ferro-silicon production plant in Norway, primarily to explore the hypothesis that chromium[III] might be carcinogenic to humans. Workers with one year or more of work were included. Hygiene studies in the plant in 1975 indicated the presence of chromium[III] and [VI] in the work environment; the atmosphere contained a mean of 0.01-0.29 mg/m³ chromium, 11-33% of which was water-soluble chromium[VI]. The 1980 study comprised 976 workers with first employment before 1960 and alive in 1953; in the 1990 report, the cohort also included those with first employment before 1965 (to make a total of 1235 workers). In the latter report, 357 deaths from all causes were observed (SMR, 81 [95% CI, 73-90]). The SIR for all cancers was 84 (132 observed; 95% CI, 70-100); the total number of lung cancers was 17 (SIR, 88 [95% CI, 56-123]). Among the 379 ferrochromium workers, there were ten cases of lung cancer [SIR, 154; 95% CI, 74-283], 12 of the prostate [SIR, 151 [95% CI, 78-262] and five of the kidney [SIR, 273; 95% CI, 89-638]. The excess of lung cancer in ferrochromium workers was higher in the 1980 study (seven cases; SMR, 226 [95% CI, 91-466]).

(e) *Other industrial exposures to chromium*

In an exploratory proportionate mortality study, Tsuchiya (1965) investigated the occurrence of cancer in 1957-59 in about 200 Japanese companies with more than 1000 employees each. A total of 492 cancer deaths occurred among 1 200 000 workers during that period. The 22 lung cancer deaths that occurred among workers in industries handling chromium compounds were compared with the Japanese mortality rate for 1958 [SMR, 220; 95% CI, 138-333]. The author pointed out that because a person had handled chromium or nickel in a factory did not necessarily imply that he had been exposed to these elements. [The Working Group noted that the design of the study did not exclude selection bias, and that exposures to chromium and a variety of carcinogens were not mutually exclusive.]

Dalager *et al.* (1980) carried out a proportionate mortality study on a group of spray painters using zinc chromate primer paints in the maintenance of aircraft at two US military bases. Spray painting was carried out mainly in air-conditioned booths, but without respirators. The study cohort consisted of 977 white male workers who had spray painted for at least three months and who had terminated employment within a ten-year period prior to 31 July 1959. The relative 'frequency' of causes of death through 1977 was generated by comparing the observed number of cases with the expected relative frequency in the white US male population. There were 202 deaths among the spray painters; 50 had died of cancer (PMR, 136 [95%

CI, 101-179]), 21 of whom had respiratory cancer (ICD 160-164; PMR, 184 [95% CI, 114-282]). The proportionate cancer mortality rate for respiratory cancer was 146 (not significant).

Bertazzi *et al.* (1981) studied the causes of death in 1954-78 for 427 workers who had been employed for at least six months between 1946 and 1977 in a plant producing paints and coatings, including chromate[VI] pigments. They found 18 deaths due to cancer *versus* 9.8 expected on the basis of national rates; there were eight lung cancer deaths, giving SMRs of 227 [95% CI, 156-633] based on local rates and 334 [95% CI, 106-434] on the basis of national rates. The authors were unable to differentiate between exposures to different paints and coatings; they stated that the primary exposure was to chromate[VI] pigments but that there was low exposure to asbestos.

Cornell and Landis (1984) studied the causes of death for 851 men who had worked in 26 US nickel/chromium foundries between 1968 and 1979 and compared them with the mortality experience of US males and of a control group of foundry workers not exposed to nickel/chromium. Sixty deaths were from lung cancer *versus* 56.9 expected in the general population; a total of 103 deaths from all other neoplasms was observed with 118.0 expected. No death from nasal cancer was observed.

Stern *et al.* (1987) followed up 9365 workers from two chrome leather tanneries in Minnesota and Wisconsin, USA, from identification of the cohort in 1940 through to December 1982. Follow-up was 95% complete. By that time, 1582 deaths had occurred, giving a SMR of 89. The SMRs for cancer of the lung, trachea and bronchus (ICD 162-163) were low in both tanneries (18 deaths; SMR, 67; 95% CI, 40-106 and 42 deaths; SMR, 93; 95% CI, 67-126) in comparison with expected rates in the respective states. [The Working Group noted that exposure to chromium was low and occurred in only a small subgroup of the workers.]

Hernberg *et al.* (1983a,b) conducted a joint Danish-Finnish-Swedish case-control study among 167 living cases of cancer of the nasal or paranasal sinuses diagnosed between 1 July 1977 and 31 December 1980, who were individually matched for country, age and sex with patients with colonic or rectal cancer. Cases and controls were interviewed by telephone. Patients who had had work-related exposures during the ten years before occurrence of the illness were excluded. Sixteen patients, many of whom were included within the category 'stainless steel welding' and 'nickel', *versus* six controls reported exposure to chromium (odds ratio, 2.7; 95% CI, 1.1-6.6). Among 21 cases categorized as having been exposed to nickel and/or chromium, including the above cases, only two had been exposed to chromium only: one spray painter (chromates) and one steel worker.

In a case-control study in North Carolina and Virginia, USA, of 160 patients (93 men, 67 women) with cancers of the nasal cavity and paranasal sinuses diag-

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nosed between 1970 and 1980, Brinton *et al.* (1984) found chromium/chromate exposure to be 5.1 times more frequent among male cases than among 290 hospital controls, based on five exposed male cases. The authors stated that the excess was associated mainly with use of chromate products in the building industry and in painting.

A hospital-based case-control study in Norway of 176 incident male lung cancer cases was performed by Kjuus *et al.* (1986). Cases were recruited between 1979 and 1983, and 176 age- and sex-matched control subjects were recruited from the same hospitals. Seven cases and six controls had been exposed to chromium and nickel compounds (welding excluded) for more than three years. The risk ratio, adjusted for smoking, was 1.4 (95% CI, 0.4-4.4).

Rafnsson and Jóhannesdóttir (1986) followed up 450 Icelandic men born between 1905 and 1945 who were licensed as masons (cement finishers). Nine deaths from cancer of the lung, trachea and bronchus (ICD 162, 163) were found (SMR, 314; 95% CI, 143-595). The eight men who had been licensed for 20 years had a SMR of 365 (95% CI, 158-720). The concentration of chromium[VI] in Icelandic cement in 1983 was 5.8-9.5 mg/kg; however, masons also work with other substances. [The Working Group noted that respiratory exposure to chromates would have been very low, suggesting that the excess may have been due to other factors.]

In an extended case-control study, Claude *et al.* (1988) further examined the possible relationship between work-related exposure and bladder cancer proposed by Claude *et al.* (1986). A total of 531 male cases were recruited from hospitals in the Federal Republic of Germany between 1977 and 1985 and were compared with sex- and age-matched controls recruited mainly from urological hospital wards. Exposure to chromium/chromate was reported for 52 cases *versus* 24 controls (odds ratio, 2.2; 95% CI, 1.4-3.5). The corresponding figures for spray painting were 49 *versus* 17 (odds ratio, 2.9; 95% CI, 1.7-4.9). Details were not given on the extent to which spray painting included exposure to chromium-containing paints. After adjustment for smoking, the rate ratio estimates for duration of exposure to chromium/chromate were (number of cases/controls in parentheses); one to nine years, 1.2 (10/8); ten to 19 years, 1.0 (9/7); 20-29 years, 2.0 (11/5); and ≥ 30 years, 3.0 (26/8), which gives a *p*-value for trend of 0.009. The corresponding rate ratios for spray painting were: 4.7 (13/2), 8.4 (8/1), 2.0 (14/9) and 2.4 (17/8). [The Working Group noted that the possibility of recall bias was high, since the risk ratios for 24/25 exposures exceeded unity.]

(f) *Environmental exposure to chromium*

The possible relation between environmental exposure to chromium and mortality from lung cancer was studied by Axelsson and Rylander (1980) in a population-based study among people living close to two Swedish ferrochromium smelt-

ers. Air concentrations of chromium near the smelter were 100-400 ng/m³. The lung cancer mortality rates in the two communities where the smelters were located were 253 per million ($p < 0.05$) and 161 per million, respectively, as compared with the county rate of 194 per million during the entire period studied (1961-75).

4. Summary of Data Reported and Evaluation

4.1 Exposure data

Chromium in the form of various alloys and compounds has been in widespread commercial use for over 100 years. Early applications included chrome pigments and tanning liquors. In recent decades, chromium has also been widely used in chromium alloys and chrome plating.

Several million workers worldwide are exposed to airborne fumes, mists and dust containing chromium or its compounds. Of the occupational situations in which exposure to chromium occurs, highest exposures to chromium[VI] may occur during chromate production, welding, chrome pigment manufacture, chrome plating and spray painting; highest exposures to other forms of chromium occur during mining, ferrochromium and steel production, welding and cutting and grinding of chromium alloys.

Data on exposure levels are available for several specific industries and job categories covering several decades. In the past, exposures to chromium[VI] in excess of 1 mg/m³ were found repeatedly in some processes, including chromium plating, chromate production and certain welding operations; exposures to total chromium have been even higher. Modern control technologies have markedly reduced exposures in some processes, such as electroplating, in recent years.

Occupational exposure has been shown to give rise to elevated levels of chromium in blood, urine and some body tissues, inhalation being the main route.

Nonoccupational sources of exposure to chromium include food, air and water, but the levels are usually several orders of magnitude lower than those typically encountered in occupational situations.

4.2 Experimental carcinogenicity data

Chromium[0]

Studies in rats by intratracheal, intramuscular and intrafemoral administration, in mice and rats by intrapleural and intraperitoneal administration and in mice, rats and rabbits by intravenous injections were inadequate to evaluate the carcinogenicity of *chromium metal* as a powder.

Chromium[III]

In studies in which *chromic acetate* was administered by the oral route to mice and rats and by intrapleural and intramuscular administration to rats, the incidence of tumours was not increased. In studies in which rats were administered *chromic oxide* by intrabronchial or oral routes, no increase in the incidence of tumours was observed. In experiments by intrabronchial implantation of *chromic chloride* or *chrome tan* (a basic chromic sulfate) in rats and by intraperitoneal administration of *chromic sulfate* in mice, the incidence of tumours was not increased. Many of these studies suffered from certain limitations. *Chromite ore* has been extensively tested in rats by intrabronchial, intrapleural and intrafemoral administration; no increase in the incidence of tumours was seen.

Chromium[VI]

Calcium chromate has been tested by inhalation in mice, by intratracheal administration in rats and hamsters, by intrabronchial administration and intrapleural administration in rats, by subcutaneous administration in mice, and by intramuscular administration in mice and rats. In the one study by inhalation in mice, there was an increase in the incidence of lung adenomas which was of borderline significance; in the single study by intratracheal administration and in the three studies by intrabronchial administration in rats, lung tumours were induced. No lung tumour was seen in hamsters after intratracheal instillation. Local tumours were produced in rats by intrapleural and in rats and mice by intramuscular administration of calcium chromate. *Chromium trioxide* (chromic acid) has been tested as a mist by inhalation at two dose levels in mice and as a solid by intrabronchial implantation in three studies in rats. In mice, a low incidence of lung adenocarcinomas was observed at the higher dose and of nasal papillomas at the lower dose; perforation of the nasal septum was observed at both dose levels. A few lung tumours were seen in two of the studies by intrabronchial administration in rats. *Sodium dichromate* has been tested in rats by inhalation, intratracheal, intrabronchial, intrapleural and intramuscular administration. Lung tumours, benign and malignant, were observed in the studies by inhalation and by intratracheal administration. No increase in the occurrence of local tumours was seen after intrabronchial, intrapleural or intramuscular administration. *Barium chromate* has been tested in rats by intrabronchial, intrapleural and intramuscular implantation. No increase in the occurrence of tumours was seen following intrabronchial implantation; the other studies were inadequate to allow an evaluation of the carcinogenicity of this compound. *Lead chromate* and derived pigments have been tested by intrabronchial implantation in rats without producing a significant increase in the incidence of tumours. Lead chromate and derived pigments have also been tested in rats by subcutaneous and intramuscular injection, producing malignant tumours at the site of injection

and, in one study, renal carcinomas. A study by intrapleural administration to rats could not be evaluated. No increase in tumour incidence was observed when lead chromate was administered intramuscularly to mice. A single subcutaneous injection of *basic lead chromate* produced a high incidence of local sarcomas in rats. *Zinc chromates* have been tested in rats by intrabronchial implantation, producing bronchial carcinomas, by intrapleural administration, producing local tumours, and by subcutaneous and intramuscular injection, producing local sarcomas. Two samples of *strontium chromate* were tested in rats by intrabronchial implantation, producing a high incidence of bronchial carcinomas; intrapleural and intramuscular injection of strontium chromate produced local sarcomas.

Other forms of chromium

A range of *roasted chromite ores* (Cr[III/VI]), often described as mixed chromium dust, and other residue materials encountered in the early stages of bichromate production have been tested extensively in mice, rats, guinea-pigs and rabbits by inhalation and by intratracheal, intrabronchial, intrapleural and intramuscular administration. The results of these tests were generally negative, although a low incidence of local tumours was observed in rats following intrapleural or intramuscular implantation of roasted chromite ore. The studies were considered to suffer from certain inadequacies. *Chromium[IV] dioxide* was tested by inhalation in rats, producing a few lung lesions of questionable nature; the study had a number of limitations.

4.3 Human carcinogenicity data

Epidemiological studies carried out in the Federal Republic of Germany, Italy, Japan, the UK and the USA of workers in the chromate production industry have consistently shown excess risks for lung cancer. The workers in this industry may be exposed to a variety of forms of chromium, including chromium[VI] and [III] compounds.

Similarly, studies carried out in the Federal Republic of Germany, France, the Netherlands, Norway, the UK and the USA of workers in the production of chromate pigments have also consistently shown excess risks for lung cancer. Workers in this industry are exposed to chromates, not only in the pigments themselves but also from soluble chromium[VI] compounds in the raw materials used in their production. Excess risk for lung cancer has been clearly established in facilities where zinc chromate was produced, although other chromium pigments were also generally made in these plants. A small study in the UK of workers producing lead chromate pigments showed no overall excess risk for lung cancer, but a nonsignificant excess risk was seen in a subgroup of workers with lead poisoning. No data were

available on risk associated with exposure to strontium chromate or to other specific chromate pigments.

In two limited reports from the UK and in a small Italian study, excesses of lung cancer were reported in workers in the chromium plating industry. In a group of persons working in die-casting and plating in the USA, similar results were seen. These findings were confirmed in a large study of chromium platers in the UK, which demonstrated an excess risk for lung cancer in platers, particularly among those with at least ten years of employment at chrome baths. Workers in this industry have been exposed to soluble chromium[VI] compounds and possibly also to nickel.

In three reports, from Norway, Sweden and the USSR, in which ferrochromium workers were studied, the overall results with regard to lung cancer were inconclusive. The major exposure in this industry is to chromium[III] compounds and to metallic chromium, although exposure to chromium[VI] may also occur.

Cases of sinonasal cancer were reported in epidemiological studies of primary chromate production workers in Japan, the UK and the USA, of chromate pigment production workers in Norway and of chromium platers in the UK, indicating a pattern of excess risk for these rare tumours.

For cancers other than of the lung and sinonasal cavity, no consistent pattern of cancer risk has been shown among workers exposed to chromium compounds.

The results of epidemiological studies of stainless-steel welders are consistent with the finding of excess mortality from lung cancer among other workers exposed to chromium[VI], but they do not contribute independently to the evaluation of chromium since welders are also exposed to other compounds. (See also the monograph on welding.)

No epidemiological study addressed the risk of cancer from exposure to metallic chromium alone.

4.4 Other relevant data

Inhaled chromium[VI] from welding and chrome-plating aerosols is readily absorbed from the respiratory tract. The degree of absorption depends on the extent of reduction of the hexavalent form to chromium[III], which is absorbed to a much lesser extent. The same factors apply to absorption from the gastrointestinal tract, although absorption by this route is generally much less than that from the respiratory tract.

Chromium[VI] compounds may cause adverse effects to the skin, the respiratory tract and, to a lesser degree, the kidneys in humans, while chromium[III] is less toxic.

Elevated levels of sister chromatid exchange were observed in workers exposed to chromium[VI] compounds in electroplating factories in four out of six studies.

Chromosomal aberrations were found in all three studies of exposed workers; an increased frequency of aneuploidy was reported in one of these studies. The two available studies on chromium[III] were inadequate to evaluate its cytogenetic effect in humans.

Chromates enter cells more readily than chromium[III] compounds and are reduced ultimately to chromium[III]. The reduction process and the subsequent intracellular activity of reduced chromium species are important for the mechanism of toxicity and carcinogenicity of chromium[VI]. Particulate chromium[III] compounds can also enter cells by phagocytosis.

Chromium[VI] compounds cross the placental barrier in greater amounts than chromium[III] compounds. Chromium trioxide increased fetal death rate, caused growth retardation and increased the frequency of skeletal deformities and of cleft palate in rodents. Developmental effects have also been reported in mice exposed to chromic chloride.

Chromium[VI] compounds of various solubilities in water were consistently active in numerous studies covering a wide range of tests for genetic and related effects. In particular, potassium dichromate, sodium dichromate, ammonium dichromate, potassium chromate, sodium chromate, ammonium chromate, chromium trioxide, calcium chromate, strontium chromate and zinc yellow induced a variety of effects (including DNA damage, gene mutation, sister chromatid exchange, chromosomal aberrations, cell transformation and dominant lethal mutation) in a number of targets, including animal cells *in vivo* and animal and human cells *in vitro*. Potassium chromate induced aneuploidy in insects, while chromium trioxide did not; various compounds induced gene mutation in insects. Potassium dichromate produced recombination, gene mutation and aneuploidy in fungi. All of these chromium[VI] compounds induced DNA damage and gene mutation in bacteria. Similar patterns were observed with zinc chromate, barium chromate, lead chromate and the derived pigments chromium orange, chromium yellow and molybdenum orange, which, however, often required preliminary dissolution in alkali or acids. A liquid chromium[VI] compound (chromyl chloride) and its vapours induced gene mutation in bacteria.

Although chromium[III] compounds were generally even more reactive than chromium[VI] compounds with purified DNA and isolated nuclei, 12 compounds of various solubilities (chromic chloride, chromic acetate, chromic nitrate, chromic sulfate, chromic potassium sulfate, chromium alum, neochromium, chromic hydroxide, chromic phosphate, chromic oxide, chromite ore and cupric chromite) gave positive results in only a minority of studies using cellular test systems, often under particular treatment conditions or at very high concentrations, which were generally orders of magnitude higher than those needed to obtain the same effects with chromium[VI] compounds. Some of the positive results could be ascribed to

contamination with traces of chromium[VI] compounds. In particular, no DNA damage was observed in cells of animals treated *in vivo* with chromic chloride, and no micronuclei were seen in cells of animals given chromic nitrate. The chromium[III] compounds tested generally did not produce DNA damage, gene mutation, sister chromatid exchange or cell transformation in cultured animal and human cells. Chromosomal aberrations were often observed with high concentrations of chromium[III] compounds. Weak effects on gene mutation and mitotic gene conversion were observed in fungi. Negative results were obtained in the large majority of tests for DNA damage and gene mutation in bacteria. Certain complexes of chromium[III] with organic ligands, which favour the penetration of chromium[III] into cells, were reported to induce DNA damage and gene mutation in bacteria and in cultured mammalian cells.

A chromium[II] compound (chromous chloride) gave negative results in *in vitro* tests with animal cells (DNA damage, chromosomal aberrations and aneuploidy). A water-insoluble chromium[0] compound (chromium carbonyl) did not induce DNA damage in bacteria.

No relevant study on the genetic and related effects of metallic chromium was available to the Working Group.

4.5 Evaluation¹

There is *sufficient evidence* in humans for the carcinogenicity of chromium[VI] compounds as encountered in the chromate production, chromate pigment production and chromium plating industries.

There is *inadequate evidence* in humans for the carcinogenicity of metallic chromium and of chromium[III] compounds.

There is *sufficient evidence* in experimental animals for the carcinogenicity of calcium chromate, zinc chromates, strontium chromate and lead chromates.

There is *limited evidence* in experimental animals for the carcinogenicity of chromium trioxide (chromic acid) and sodium dichromate.

There is *inadequate evidence* in experimental animals for the carcinogenicity of metallic chromium, barium chromate and chromium[III] compounds.

The Working Group made the overall evaluation on chromium[VI] compounds on the basis of the combined results of epidemiological studies, carcinogenicity studies in experimental animals, and several types of other relevant data which support the underlying concept that chromium[VI] ions generated at critical sites in the target cells are responsible for the carcinogenic action observed.

¹For definitions of the italicized terms, see Preamble, pp. 33-37

Overall evaluation

Chromium[VI] *is carcinogenic to humans* (Group 1).

Metallic chromium and chromium[III] compounds *are not classifiable as to their carcinogenicity to humans* (Group 3).

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- American Chrome & Chemicals (undated e) *Product Data Sheet: Chromic Acid* (CrO_3), Corpus Christi, TX
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Exhibit 44

<p style="text-align: right;">Page 2</p> <p>1 2 3 4 5 Videotaped Deposition of REBECCA 6 SMITH-BINDMAN, M.D., Volume I, taken on behalf of 7 Johnson & Johnson, at Levin Simes Abrams LLP, 8 1700 Montgomery Street, Suite 250, San Francisco, 9 California 94111, beginning at 9:20 a.m. and ending 10 at 4:01 p.m., on February 7, 2019, before MARY J. 11 GOFF, California Certified Shorthand Reporter No. 12 13427. 13 14 15 16 17 18 19 20 21 22 23 24 25</p>	<p style="text-align: right;">Page 4</p> <p>1 APPEARANCES (continued): 2 For Plaintiffs 3 Restaino Law LLC 4 BY: JOHN M. RESTAINO JUNIOR 5 Attorney at Law 6 130 Forest Street 7 Denver, Colorado 80220 8 jrestaino@restainollc.com 9 720-891-7921 10 11 12 For Defendant Johnson & Johnson 13 Tucker Ellis LLP 14 BY: MICHAEL C. ZELLERS 15 Attorney at Law 16 515 South Flower Street 17 42nd Floor 18 Los Angeles, California 90071 19 michael.zellers@tuckerellis.com 20 213-430-3301 21 22 23 24 25</p>
<p style="text-align: right;">Page 3</p> <p>1 APPEARANCES: 2 3 For Plaintiffs 4 Beasley Allen Law Firm 5 BY: P. LEIGH O'DELL 6 MARGARET M. THOMPSON, MD, JD, MPAff 7 Attorney at Law 8 218 Commerce Street 9 Montgomery, Alabama 36103 10 leigh.odell@beasleyallen.com 11 334-269-2343 12 For Plaintiffs 13 Robinson Calcagnie, Inc. 14 BY: CYNTHIA L. GARBER 15 Attorney at Law 16 19 Corporate Plaza Drive 17 Newport Beach, California 92660 18 cgarber@robinsonfirm.com 19 For Plaintiffs 20 Wilentz, Goldman & Spitzer P.A. 21 Daniel R. Lapinski 22 Attorney at Law 23 90 Woodbridge Center Drive, 24 Suite 900 Box 10 25 Woodbridge, New Jersey 07095-0958</p>	<p style="text-align: right;">Page 5</p> <p>1 APPEARANCES (continued): 2 For Defendant Johnson & Johnson 3 Skadden, Arps, Slate, Meagher & Flom, LLP. 4 BY: BENJAMIN HALPERIN 5 Attorney at Law 6 4 Times Square 7 New York, New York 10036 8 benjamin.halperin@skadden.com 9 212-735-2453 10 11 12 For Defendant Imerys 13 Dykema 14 BY: JANE BOCKUS 15 Attorney at Law 16 112 E. Pecan Street 17 Suite 1800 18 San Antonio, Texas 78205 19 jbockus@dykema.com 20 210-554-5549 21 22 23 24 25</p>

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<p>1 APPEARANCES (continued):</p> <p>2</p> <p>3 For Defendants PTI Union, LLC and PTI Royston, LLC</p> <p>4 Tucker Ellis LLP</p> <p>5 BY: CAROLINE M. TINSLEY</p> <p>6 Attorney at Law</p> <p>7 100 South 4th Street</p> <p>8 Suite 600</p> <p>9 St. Louis, Missouri, 63102</p> <p>10 caroline.tinsley@tuckerellis.com</p> <p>11</p> <p>12 Videographer:</p> <p>13 Joseph Morgas</p> <p>14</p> <p>15</p> <p>16</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>	<p>1 EXHIBITS CONTINUED: PAGE</p> <p>2 Exhibit 6 IARC Monographs, Volume 93 35</p> <p>3</p> <p>4 Exhibit 7 J&J article by Owen Dyer, BMJ 36</p> <p>5</p> <p>6 Exhibit 8 IARC Volumes 1-123 36</p> <p>7</p> <p>8 Exhibit 9 "On Talc Translocation from the Vagina" article 36</p> <p>9</p> <p>10 Exhibit 10 Alterations in Gene Expression article 37</p> <p>11</p> <p>12 Exhibit 11 Draft Screening Assessment, 12/18 38</p> <p>13</p> <p>14 Exhibit 12 (Binder) Talc Articles I 39</p> <p>15</p> <p>16 Exhibit 13 (Binder) Talc Articles II 39</p> <p>17 (Exhibit 21 is inside Exhibit 13)</p> <p>18 Exhibit 14 CV of Smith-Bindman, MD 53</p> <p>19 Exhibit 15 List of articles 54</p> <p>20 Exhibit 16 9/24/18 e-mail string forest plots 76</p> <p>21</p> <p>22 Exhibit 17 Rule 26 Expert Report of Smith-Bindman, MD 90</p> <p>23</p> <p>24 Exhibit 18 The Association Between Talc Use and Ovarian Cancer article 95</p> <p>25</p>

<p style="text-align: right;">Page 10</p> <p>1 EXHIBITS CONTINUED: PAGE</p> <p>2 Exhibit 19 NCI, SEER Training Modules Risk Factors 130</p> <p>3</p> <p>4 Exhibit 20 NCI article, Ovarian, Fallopian Tube and Primary Peritoneal Cancer Prevention PDQ-Health Professional Version 132</p> <p>5</p> <p>6</p> <p>7 Exhibit 21 Handwritten notes (Inside Binder Exhibit 13) 156</p> <p>8</p> <p>9 Exhibit 22 Genital Talc Exposure and Risk of Ovarian Cancer article 179</p> <p>10</p> <p>11 Exhibit 23 Genital Powder Exposure article 179</p> <p>12</p> <p>13 Exhibit 24 9/29/18 e-mail string 184</p> <p>14</p> <p>15 Exhibit 25 Perineal Talc Exposure article 189</p> <p>16</p> <p>17 Exhibit 26 Letter to Samuel Epstein, MD 203</p> <p>18</p> <p>19 Exhibit 27 IARC Agents Classified by IARC Monographs, Volumes 1-123 206</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>	<p style="text-align: right;">Page 12</p> <p>1 REBECCA SMITH-BINDMAN, M.D., VOLUME I,</p> <p>2 being first duly sworn or affirmed to testify to the</p> <p>3 truth, the whole truth, and nothing but the truth,</p> <p>4 was examined and testified as follows:</p> <p>5 EXAMINATION BY COUNSEL FOR THE DEFENDANTS</p> <p>6 BY MR. ZELLERS:</p> <p>7 Q State your name.</p> <p>8 A Rebecca Smith-Bindman.</p> <p>9 Q Dr. Bindman, we are here today to take</p> <p>10 your deposition in the talcum powder MDL litigation.</p> <p>11 Are you aware of that?</p> <p>12 A I am.</p> <p>13 Q Have you been deposed before?</p> <p>14 A I have.</p> <p>15 Q On how many occasions?</p> <p>16 A Three to four times.</p> <p>17 Q Have you ever testified at trial?</p> <p>18 A I have.</p> <p>19 Q On how many occasions?</p> <p>20 A One.</p> <p>21 Q You are generally familiar with the rules</p> <p>22 we're going to follow here today?</p> <p>23 A I am.</p> <p>24 Q If at any time I ask you a question or any</p> <p>25 counsel asks you a question that you don't</p>
<p style="text-align: right;">Page 11</p> <p>1 San Francisco, California</p> <p>2 February 7, 2019</p> <p>3 9:20 a.m.</p> <p>4</p> <p>5 REBECCA SMITH-BINDMAN, M.D.,</p> <p>6 being first duly sworn or affirmed to testify to the</p> <p>7 truth, the whole truth, and nothing but the truth,</p> <p>8 was examined and testified as follows:</p> <p>9 THE VIDEOGRAPHER: We are now on the</p> <p>10 record. My name is Joseph morgue. I'm a</p> <p>11 videographer for Golkow Litigation Services.</p> <p>12 Today's date is February 7, 2019. The</p> <p>13 time on the video monitor is 9:20 a.m.</p> <p>14 This video deposition is being held at</p> <p>15 1700 Montgomery Street, Suite 250, San Francisco,</p> <p>16 California, in the matter In Re: Johnson & Johnson</p> <p>17 Talcum Powder Products Marketing, Sales Practices,</p> <p>18 and Products Liability Litigation, for the United</p> <p>19 States District Court, for the District of</p> <p>20 New Jersey.</p> <p>21 The deponent is Dr. Rebecca Smith-Bindman.</p> <p>22 Counsel will be noted on the stenographic record.</p> <p>23 The court reporter is Mary Goff. She will now</p> <p>24 administer the oath.</p> <p>25</p>	<p style="text-align: right;">Page 13</p> <p>1 understand, please don't answer it. Tell us you</p> <p>2 don't understand, and we'll rephrase the question or</p> <p>3 repeat it so it's clear to you.</p> <p>4 Can you do that?</p> <p>5 A I can.</p> <p>6 Q If you answer a question, is it fair for</p> <p>7 us to assume that you understood it?</p> <p>8 A It is.</p> <p>9 Q Please don't guess or speculate as to any</p> <p>10 answers. If you don't know the answer to a question</p> <p>11 or it would call you to guess or speculate, tell us.</p> <p>12 Can you do that?</p> <p>13 A I can.</p> <p>14 Q If at any time you need to take a break as</p> <p>15 we proceed through the day, please tell us. And</p> <p>16 once we finish whatever line of questioning we're</p> <p>17 involved with, then we will take a break.</p> <p>18 A Okay.</p> <p>19 Q Tell us the times that you have been</p> <p>20 deposed. When is the last time you were deposed?</p> <p>21 A I think approximately six years ago.</p> <p>22 Q What was the litigation or the matter?</p> <p>23 A I have been deposed a few times. I'm not</p> <p>24 sure which happened when --</p> <p>25 Q That's fine.</p>

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1 A -- but I can tell you in general what they
 2 were about.
 3 Q Tell us -- the three to four times that
 4 you have been deposed, will you tell us what each of
 5 those matters was?
 6 A Yes. I am in addition to being an
 7 epidemiologist, I'm a clinical radiologist. And
 8 each of those cases had to do with diagnosis and
 9 communication within medical malpractice cases.
 10 One case had to do with a delayed
 11 diagnosis of breast cancer and not communicating
 12 results.
 13 One case had to do with a misdiagnosis of
 14 a first trimester pregnancy loss.
 15 One case had to do with misdiagnosis of a
 16 complication of a twin/twin pregnancy. I think
 17 those are the cases I was deposed in.
 18 Q All of the cases in which you have been
 19 deposed previously have been medical malpractice
 20 cases?
 21 A Yes.
 22 Q Were those cases in which you had provided
 23 treatment to a patient or were they cases in which
 24 you were an expert witness independent of that
 25 particular plaintiff?

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1 A For each of those cases, I was an expert
 2 witness. I had never personally been involved in a
 3 medical malpractice cases.
 4 Q Were each of those cases in the
 5 San Francisco area or where were they located?
 6 A None of those cases were in the
 7 San Francisco area. One of them was in Huntsville
 8 Alabama, one was in Northern California, and one was
 9 in Southern California.
 10 Q Do you remember the names of any of those
 11 cases?
 12 A I do not.
 13 Q Do you remember the name of the lawyer or
 14 lawyers that you worked with in those cases?
 15 A I do not.
 16 Q Did you testify in those cases on behalf
 17 of the plaintiff or on behalf of a defendant?
 18 A They were split. So I have been involved
 19 in cases on both sides.
 20 Q Well, my understanding is you have been
 21 involved in three prior litigations; is that right
 22 --
 23 MS. O'DELL: Object to the form.
 24 Q (BY MR. ZELLERS) -- in which you served as
 25 an expert witness and were deposed?

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1 A And -- and I was deposed.
 2 MS. O'DELL: Excuse me.
 3 Q (BY MR. ZELLERS) Yes. So three prior
 4 litigations in which you served as an expert and you
 5 were deposed; is that right?
 6 A I --
 7 MS. O'DELL: Object to the form. I think
 8 she said four, but --
 9 MR. ZELLERS: Well, she said three to
 10 four. But then when she was telling us about those
 11 cases --
 12 A -- so I remember what was fourth case was.
 13 Q (BY MR. ZELLERS) All right. What was the
 14 fourth case?
 15 A There was a case of delay in the diagnosis
 16 of an ovarian cancer.
 17 Q Where was that case?
 18 A Somewhere in the middle of the country.
 19 Q When did you testify in that case?
 20 A I -- I only testified in a single case.
 21 So it -- do you mean deposed?
 22 Q Yes. When were you deposed in that case?
 23 A I -- sometime between -- all of the cases
 24 were sometime between six and 12 years ago. I'm
 25 not --

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1 Q All right. Did --
 2 A -- sure I remember the years.
 3 Q The case in which you testified as an
 4 expert witness in the delay of diagnosis of ovarian
 5 cancer, were you testifying for the defense or for
 6 the plaintiff?
 7 A I believe that case was for the defense.
 8 Q Do you remember the name of the plaintiff?
 9 A I do not.
 10 Q Do you remember the name of the defendant?
 11 A I do not.
 12 Q Do you remember the name of the attorney
 13 who retained you?
 14 A I do not.
 15 Q Do you remember where in the middle of the
 16 country that case was pending?
 17 A I do not.
 18 Q You stated that you have testified one
 19 time at trial; is that right?
 20 A Yes.
 21 Q Where did you testify at trial?
 22 A That was Huntsville -- the Fayetteville,
 23 Alabama case.
 24 Q In that case, did you testify for the
 25 plaintiff or the defense?

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1 A For the plaintiff.
 2 Q Do you remember how long ago it was?
 3 A In the ballpark of seven or eight years
 4 ago.
 5 Q The Northern California case that you gave
 6 deposition testimony in that -- in, was that for the
 7 plaintiff or the defense?
 8 A I don't remember.
 9 Q Southern California, that medical
 10 malpractice case, did you testify for the plaintiff
 11 or the defense?
 12 A Can I go back? I -- I do remember.
 13 So the Northern California case was the
 14 plaintiff. The Southern California case was the
 15 defense.
 16 Q Do you remember the attorneys that you
 17 worked with in the Northern California case?
 18 A I do not.
 19 Q The Southern California case?
 20 A I do not.
 21 Q Do you remember the name of any of the
 22 parties in any of the cases in which you have either
 23 given deposition testimony in or trial testimony in?
 24 A I do not.
 25 Q Today I'm going to ask you questions about

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1 talcum powder or baby powder. Can we agree that
 2 when I refer during the deposition to products, to
 3 talc products, talcum powder products, baby powder,
 4 or Shower to Shower at issue in this MDL, that I am
 5 referring to the baby powder product manufactured by
 6 Johnson & Johnson Consumer Products, Inc., and the
 7 Shower to Shower product that was formerly
 8 manufactured by Johnson & Johnson Consumer Products,
 9 Inc.?
 10 A Yes.
 11 Q How would you define the area of expertise
 12 in which you were offering opinions in this case,
 13 "this case" being the talc MDL?
 14 A I was asked to provide an expert review in
 15 the area of epidemiology, ovarian cancer and its
 16 causes, the health effects of talc powder products.
 17 I think those are the main areas.
 18 Q Are -- are you testifying today as an
 19 epidemiologist?
 20 A Yes.
 21 MS. O'DELL: Object to --
 22 A Am --
 23 MS. O'DELL: -- the form.
 24 A -- I bringing expertise to that?
 25 Q (BY MR. ZELLERS) Yes.

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1 A Yes.
 2 Q You are not testifying here today as a
 3 radiologist; is that right?
 4 MS. O'DELL: Object to the form.
 5 A I think some of my experiences as a
 6 radiologist are highly relevant to my expertise, and
 7 so there are some questions that I think that that
 8 is very relevant.
 9 Q (BY MR. ZELLERS) Are there any areas in
 10 which you anticipate providing expert testimony in
 11 this litigation, other than in the areas of
 12 epidemiology and radiology?
 13 MS. O'DELL: Object to the form.
 14 A I mentioned ovarian cancer. So risk
 15 factors for ovarian cancer falls into epidemiology.
 16 The mechanism of ovarian cancer, the
 17 pathophysiology, the biological processes are not
 18 technically epidemiology. They're related, and so
 19 some of my opinions, I think, would fall into that
 20 category.
 21 Q (BY MR. ZELLERS) How would you define that
 22 area of expertise for which you are providing expert
 23 opinions?
 24 MS. O'DELL: Object to the form.
 25 Q (BY MR. ZELLERS) We have got that you are

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1 going to provide expert opinions relating to
 2 epidemiology. You're going to provide expert
 3 opinions relating to radiology.
 4 Are there any other areas that you intend
 5 to provide expert opinions in?
 6 MS. O'DELL: Other than what she has just
 7 described?
 8 Q (BY MR. ZELLERS) Well, other than
 9 epidemiology and radiology.
 10 MS. O'DELL: Object to the form. She gave
 11 another -- a host -- a suite of things she expected
 12 to testify on, but --
 13 MR. ZELLERS: And so --
 14 MS. O'DELL: -- I'll object to the form.
 15 MR. ZELLERS: -- yeah, thank you.
 16 A Could you repeat back to me what I have
 17 already said?
 18 Q (BY MR. ZELLERS) No. I'm asking you what
 19 you are going to provide expert testimony in, what
 20 you consider yourself to be an expert in.
 21 I understand epidemiology, and I
 22 understand the epidemiology opinions you are going
 23 to give, relate to whether or not talcum powder is
 24 associated with ovarian cancer, whether or not
 25 talcum powder causes ovarian cancer, so I believe

<p style="text-align: right;">Page 22</p> <p>1 those are epidemiology-based opinions. 2 I also understand that you have a -- your 3 training and your background is in radiology and 4 that you will provide, to the extent relevant, 5 radiology opinions. 6 But you're not testifying here today as a 7 gynecologic oncologist, are you? 8 A I am not. 9 Q You are not testifying here today as an 10 expert in asbestos; is that fair? 11 MS. O'DELL: Object to the form. 12 A I am going to provide opinions, if asked, 13 about the health effects of asbestos. 14 Q (BY MR. ZELLERS) Are you an expert or do 15 you consider yourself to be an expert in asbestos? 16 MS. O'DELL: Object to the form. 17 A The question is about asbestos, in 18 general, and I consider myself an expert on the 19 health effects of asbestos. 20 Q (BY MR. ZELLERS) Does that mean that you 21 are an expert in asbestos or simply looking at 22 studies that have evaluated the epidemiology of 23 asbestos and asbestos exposure to certain 24 conditions? 25 MS. O'DELL: Object to the form.</p>	<p style="text-align: right;">Page 24</p> <p>1 Q -- not an expert -- well -- and let me 2 withdraw that. 3 You have produced an expert report in this 4 case; is that right? 5 A I have. 6 Q Let's mark a couple of things at the 7 outset. 8 Deposition Exhibit 1 is copy of the Notice 9 of Deposition. 10 (Exhibit 1 was marked for identification 11 and is attached to the transcript.) 12 MS. O'DELL: Thank you. 13 Q (BY MR. ZELLERS) Have you seen the Notice 14 of Deposition prior to today? 15 A Yes, I have. 16 Q Have you either brought with you or 17 through counsel have they brought all of the 18 materials that you believe are responsive to the 19 Deposition Notice? 20 MR. ZELLERS: And, Ms. O'Dell, I recognize 21 that you have objected to the Deposition Notice and 22 the record will reflect that. 23 MS. O'DELL: And just so I have a chance 24 to say something, we'll just reassert those 25 objections now.</p>
<p style="text-align: right;">Page 23</p> <p>1 A I think there are a lot of acts -- aspects 2 of asbestos, so I would absolutely not consider 3 myself an expert on the geology of asbestos or in 4 the mechanism of mining asbestos. 5 But I would consider myself an expert on 6 the changes to the body that can be the result of 7 exposure to asbestos in the context of epidemiology 8 studies, but also in the context of molecular 9 changes, cellular changes like that. 10 And -- and those technically are probably 11 not in the category of epidemiology, but would 12 overlap other areas of my training and experience, 13 such as pathology and... 14 Q You are not an expert in the testing of 15 asbestos; is that fair? 16 A I -- I would, yes, agree. 17 Q You are not an expert in the different 18 forms and types of asbestos -- 19 A I -- 20 Q -- correct? 21 A -- I -- correct. 22 Q Okay. 23 A I'm not an expert in those types of -- 24 Q You are -- 25 A -- asbestos.</p>	<p style="text-align: right;">Page 25</p> <p>1 Dr. Smith-Bindman has brought with her 2 documents subject to our objections. 3 MR. ZELLERS: And I would really like 4 Dr. Smith-Bindman to answer the question. 5 MS. O'DELL: I'm sure she's ready to do 6 that. 7 A To the best of my knowledge, I have 8 responded or brought or provided all of -- 9 Q (BY MR. ZELLERS) You -- 10 A -- those items. 11 Q -- you are not aware of items that are 12 called for in the Deposition Notice, what we have 13 marked as Exhibit 1 that have not been produced or 14 not available here today; is that right? 15 A That's correct. 16 Q Ms. O'Dell and I spoke earlier about your 17 invoices, and apparently you do have some invoices 18 relating to your work in this matter. At some point 19 today we'll collect those and we will mark those. 20 (Exhibit 2 was marked for identification 21 and is attached to the transcript.) 22 Q (BY MR. ZELLERS) Deposition Exhibit 2 is 23 your report in this matter; is that right? 24 MS. O'DELL: Thank you. 25 A Okay. Yes.</p>

<p style="text-align: right;">Page 26</p> <p>1 Q (BY MR. ZELLERS) Does your report in this 2 matter, Deposition Exhibit 2, contain all of the 3 opinions that you intend to offer at trial or at any 4 hearing in this matter? 5 A The report summarizes my opinions. I have 6 written in the report. As new information comes 7 available, I may take that into account as well. 8 So when we began, counsel mentioned a few 9 additional papers that I had seen since the time my 10 report was written. And so those are -- are -- 11 won't -- have not changed my views, but those are 12 not necessarily referenced in this report. 13 Q In terms of your opinions and the opinions 14 that you expect to render in this matter, either at 15 trial or any hearing, those opinions are contained 16 in your report which we marked as Exhibit 2, 17 correct? 18 MS. O'DELL: Object to the form. 19 A I have not, since writing my report, seen 20 any documents that have changed my opinions. 21 But as I continue to keep up with the 22 published literature, my opinions may reflect 23 changing documents that I have seen since the time 24 my report was generated. 25</p>	<p style="text-align: right;">Page 28</p> <p>1 Q Okay. Right now all I want to do is get a 2 list of what you have looked at and considered since 3 you prepared your report. 4 A I have seen an updated testing report by 5 Mr. Longo. 6 I have seen a report and deposition by 7 Mr. Cooke. I -- I think those are the... 8 Q You -- counsel for Plaintiffs, Ms. O'Dell, 9 told me before the deposition that you also have 10 looked at a health assessment from Health Canada or 11 a risk assessment; is -- is that correct? 12 A Yes, that's correct. 13 Q All right. Did you also look at a 14 meta-analysis that was performed or at least the 15 draft of a meta-analysis by the first name, author, 16 Thayer (phonetic)? 17 A I -- I saw that report briefly. 18 Q Anything else that you have reviewed 19 and/or considered that is not included in the 20 materials that you reference either in your list of 21 references or in your Materials Considered List? 22 A There was also a series of reports in -- 23 in The New York Times and Reuters and a summary of 24 that in the BMJ, which I have seen since I have 25 issued my report.</p>
<p style="text-align: right;">Page 27</p> <p>1 Q (BY MR. ZELLERS) All I can do is ask you 2 questions today. As of today, does your report 3 contain the opinions that you expect to provide at 4 any trial or hearing in this matter? 5 A Yes, they do. 6 Q My understanding from one of your prior 7 answers is that you have reviewed some additional 8 materials since you prepared and signed your report 9 on or about November 15 of 2018; is that right? 10 A That is correct. 11 Q Those materials, you believe, support the 12 opinions that you have put in your report, but have 13 not changed your opinions; is -- 14 A It -- 15 Q -- that right? 16 A -- that's correct. 17 Q What new or additional materials have you 18 reviewed and considered since preparing your report 19 on November 15, 2018? 20 A So I have seen a draft of a publication -- 21 submitted for publication by Dr. Saed about the 22 cellular and molecular changes to cell lines of 23 being exposed to various talcum powder products, 24 which I think is an important paper that has 25 influenced my views.</p>	<p style="text-align: right;">Page 29</p> <p>1 Q Are you basing any of your opinions on the 2 Reuters or New York Times articles? 3 A Those reports support my opinions, but no, 4 I'm not basing my report on -- on those. 5 Q Ms. O'Dell also provided me with a list 6 materials that she has represented that you have 7 reviewed since you prepared your report. 8 It's a series of Imerys documents. It's 9 one J&J produced document. And then the last item 10 listed is an Amended Expert Report of Robert Cooke. 11 Have you reviewed those materials since 12 preparing your report? 13 A So yes, the -- the Mr. Cooke report, which 14 is one I mentioned. Yes, I have seen the Imerys 15 report. And I can't remember what you said, the 16 Johnson & Johnson? 17 Q Are those additional documents or 18 materials that you have reviewed since preparing 19 your report? 20 A I'm sorry. I understand the question. I 21 don't remember what the Johnson & Johnson material 22 was. 23 Q I -- 24 A You listed it. I just don't -- 25 Q -- well, I didn't --</p>

<p style="text-align: right;">Page 30</p> <p>1 A -- remember that.</p> <p>2 Q -- list it. This was a list that was</p> <p>3 prepared and provided to me by counsel for</p> <p>4 Plaintiffs so --</p> <p>5 MS. O'DELL: But I don't think he</p> <p>6 characterized the documented in any way other than</p> <p>7 the Bates number, so -- so it's a J&J document --</p> <p>8 A What is that item?</p> <p>9 MS. O'DELL: -- that's just the Bates</p> <p>10 number for that particular document. And it's</p> <p>11 the -- the test results that you reviewed yesterday.</p> <p>12 A Yes.</p> <p>13 (Exhibit 3 was marked for identification</p> <p>14 and is attached to the transcript.)</p> <p>15 Q (BY MR. ZELLERS) Are all of the documents</p> <p>16 contained on Exhibit 3, the -- a listing that was</p> <p>17 put together by counsel for the Plaintiffs,</p> <p>18 documents that you reviewed yesterday in preparation</p> <p>19 for your deposition today?</p> <p>20 A Yes.</p> <p>21 Q Are those documents that were selected by</p> <p>22 plaintiffs' counsel to show you to help prepare you</p> <p>23 for the deposition?</p> <p>24 MS. O'DELL: Object to the form.</p> <p>25 A The document are ones that I asked for to</p>	<p style="text-align: right;">Page 32</p> <p>1 is that right?</p> <p>2 A Yes, I did.</p> <p>3 MS. O'DELL: Object to the form.</p> <p>4 Q (BY MR. ZELLERS) You asked for documents</p> <p>5 that were both positive and negative relating that</p> <p>6 testing; is that right?</p> <p>7 A Yes.</p> <p>8 Q Do you believe that you have now seen, as</p> <p>9 part of your review, all documents relating to the</p> <p>10 testing of Johnson's baby powder and/or Shower to</p> <p>11 Shower powder?</p> <p>12 A I --</p> <p>13 MS. O'DELL: Object to the form.</p> <p>14 A -- I do not believe I have seen the</p> <p>15 entirety of the testing results.</p> <p>16 Q (BY MR. ZELLERS) Was it your request that</p> <p>17 you see whatever pertinent documents that were</p> <p>18 relating to the testing of the baby powder?</p> <p>19 A It was not my request. I wanted to</p> <p>20 understand, in general, what kind of testing had</p> <p>21 been done. I -- I was not planning to delve into</p> <p>22 the entirety of testing.</p> <p>23 Q Any other materials that you have reviewed</p> <p>24 prior -- strike that -- subsequent to preparing your</p> <p>25 report, which we marked as Exhibit 2?</p>
<p style="text-align: right;">Page 31</p> <p>1 see testing results, both positive and negative,</p> <p>2 from Johnson & Johnson. So I requested documents</p> <p>3 that would show that, and I believe that's what each</p> <p>4 of these were provided for.</p> <p>5 Q When did you make that request to</p> <p>6 plaintiffs' counsel?</p> <p>7 MS. O'DELL: And Mr. Zellers is -- he can</p> <p>8 ask you when you made the request. In terms of the</p> <p>9 specifics of the request or conversations with</p> <p>10 counsel, those would be protected, and I would</p> <p>11 instruct you not to -- to disclose those.</p> <p>12 A To not say when I read the request?</p> <p>13 MS. O'DELL: You can say when you gave the</p> <p>14 request. But the substance of the request or the</p> <p>15 substance of the discussions, I would have ask you</p> <p>16 not to --</p> <p>17 A Okay.</p> <p>18 MS. O'DELL: -- testify to those.</p> <p>19 Q (BY MR. ZELLERS) My question again is:</p> <p>20 When did you make the request for the documents that</p> <p>21 are identified on Exhibit 3?</p> <p>22 A I believe it was a few weeks ago.</p> <p>23 Q You made a request for testing documents</p> <p>24 of talcum powder used in Johnson & Johnson Consumer,</p> <p>25 Inc., baby powder or former Shower to Shower powder;</p>	<p style="text-align: right;">Page 33</p> <p>1 A None that come to mind.</p> <p>2 Q You have brought with you here today</p> <p>3 several notebooks and it looks like a blue folder;</p> <p>4 is that right?</p> <p>5 A Yes.</p> <p>6 Q What is contained in the blue folder that</p> <p>7 you brought here today?</p> <p>8 A Primarily in the blue folder are either</p> <p>9 additional documents that I have reviewed since I</p> <p>10 wrote my report, but also a few documents that -- in</p> <p>11 preparation for the deposition, I went through my</p> <p>12 report and pulled some articles to look at in</p> <p>13 greater depth, and so I brought those with --</p> <p>14 Q So --</p> <p>15 A -- me.</p> <p>16 Q -- in the blue folder are materials that</p> <p>17 you pulled out to have available for the deposition</p> <p>18 today for your use as needed in responding to</p> <p>19 questions that were asked?</p> <p>20 A Yes, that's correct.</p> <p>21 Q Can I see you blue folder, please? And,</p> <p>22 Dr. Smith-Bindman, have you taken any medications</p> <p>23 that impair your ability to answer questions today?</p> <p>24 A I have not.</p> <p>25 Q All right. The first document in your</p>

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1 blue folder is a document, "Reproductive Sciences"
 2 at the top, "Molecular basis Supporting the
 3 Association of Talcum Powder Use with Increased Risk
 4 of Ovarian Cancer."
 5 The first named author is Nicole Fletcher.
 6 And is this the article by Dr. Saed that
 7 you sold me about?
 8 A Yes, it is.
 9 Q There are a number of notes and
 10 highlighting that are contained in the document.
 11 Are all of those your notes and highlighting?
 12 A They are.
 13 Q We'll mark your copy of Dr. Saed's paper
 14 as Exhibit 4.
 15 (Exhibit 4 was marked for identification
 16 and is attached to the transcript.)
 17 Q (BY MR. ZELLERS) The next paper in your
 18 blue folder that you brought here today is a
 19 document with the first named author, Fiume,
 20 F I U M E. The title is "Safety Assessment of Talc
 21 as Used in Cosmetics."
 22 It appeared in the International Journal
 23 of Toxicology. Again, there's highlighting in the
 24 document and underlying lining.
 25 Did you do the highlighting and did you do

Page 35

1 the underlining in this document?
 2 A Yes, I did.
 3 Q We'll mark that document, your copy, as
 4 Exhibit 5.
 5 (Exhibit 5 was marked for identification
 6 and is attached to the transcript.)
 7 Q (BY MR. ZELLERS) I see here that there is
 8 the IARC monograph dated 2010 on the evaluation of
 9 carcinogenic risk to humans.
 10 The bottom part of page 1 is torn off. Do
 11 you know why that is?
 12 A I do not.
 13 Q All right. So the first page gives a date
 14 reference of 2010. The second page gives -- well,
 15 it also lists a 2006 date and a 2010 date. There is
 16 highlighting throughout.
 17 Whose highlighting is contained in the
 18 document that we'll mark as Exhibit 6?
 19 A That would be mine.
 20 (Exhibit 6 was marked for identification
 21 and is attached to the transcript.)
 22 Q (BY MR. ZELLERS) We then have a news
 23 article from the British Medical Journal that was
 24 published December 28 of 2008. It's just a one-page
 25 document with underlining and writing on it.

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1 Are those your notations?
 2 A Yes, they are.
 3 Q All right. We'll mark that as Exhibit 7.
 4 (Exhibit 7 was marked for identification
 5 and is attached to the transcript.)
 6 (Exhibit 8 was marked for identification
 7 and is attached to the transcript.)
 8 Q (BY MR. ZELLERS) Exhibit 8 are the
 9 classifications of the International Agency for
 10 Research on Cancer or IARC.
 11 Are you generally familiar with the IARC
 12 classifications relating to the carcino --
 13 carcinogenicity of different agents?
 14 A I am.
 15 Q The next document in your folder that also
 16 has some underlining and highlighting is on "Talc
 17 Translocation from the Vagina to the Oviducts and
 18 Beyond."
 19 (Exhibit 9 was marked for identification
 20 and is attached to the transcript.)
 21 Q (BY MR. ZELLERS) This is an article that
 22 was published in 1985. The first named author is
 23 A.P. Wehner.
 24 Is this also a document that you brought
 25 here today?

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1 A It is.
 2 Q The highlighting in the document, is that
 3 your document -- strike that.
 4 Is that your highlighting?
 5 A It -- it is.
 6 Q Are all of these documents either on your
 7 reference list or on your Materials Considered List,
 8 other than what you told us about at the start of
 9 the deposition?
 10 A Yes.
 11 Q We have Deposition Exhibit 47 from the
 12 Pier deposition. I will not mark that.
 13 We have an article here by Shukla,
 14 S H U K L A, "Alterations in Gene Expression in
 15 Human Mesothelial Cells Correlate with Mineral
 16 Pathogenicity."
 17 (Exhibit 10 was marked for identification
 18 and is attached to the transcript.)
 19 Q (BY MR. ZELLERS) Is that a document that
 20 you brought here today?
 21 A Yes, it is.
 22 Q Are the highlights and writing on that
 23 document yours?
 24 A Yes, they are.
 25 Q You have an article by Biz'Zard that was

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1 published in -- is that -- Phytotherapy Research,
 2 2007; is that right?
 3 A Yes.
 4 Q There do not appear to be any handwriting
 5 on that document, so I won't mark it.
 6 We have got the Hopkins Deposition
 7 Exhibit 28. There's no highlighting on that
 8 document.
 9 And then we have the "Draft Screening
 10 Assessment" from Health Canada dated December 2018.
 11 Is the highlighting in that document
 12 yours?
 13 A Yes, it is.
 14 Q All right. We'll mark that as
 15 Deposition Exhibit 11.
 16 (Exhibit 11 was marked for identification
 17 and is attached to the transcript.)
 18 Q (BY MR. ZELLERS) Have we covered all of
 19 the documents that you have brought with you today
 20 in your blue folder?
 21 A Yes.
 22 Q All right. Let me see your two notebooks
 23 that you also have brought with you today. One
 24 notebook is "Talc Articles I." The second notebook
 25 is "Talc Articles II."

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1 Are all of the articles that are contained
 2 in these two notebooks, articles that are contained
 3 either on your reference list or on your reliance
 4 materials list?
 5 A Yes, they are.
 6 Q As I go through this quickly, it appears
 7 that there is underlining and highlighting of the
 8 articles that you have brought here today; is that
 9 right?
 10 A Yes, it is.
 11 Q Is all of the highlighting and underlining
 12 and marking, are those your highlights and marking?
 13 A Yes, they are.
 14 Q Who prepared the notebooks? And let's
 15 mark Talc Articles I, the entire notebook as
 16 Exhibit 12.
 17 (Exhibit 12 was marked for identification
 18 and is attached to the transcript.)
 19 Q (BY MR. ZELLERS) Talc Articles II, the
 20 entire notebook, as Exhibit 13.
 21 (Exhibit 13 was marked for identification
 22 and is attached to the transcript.)
 23 Q (BY MR. ZELLERS) Who prepared Exhibits 12
 24 and 13 for you?
 25 A I did.

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1 Q Did you have any staff that helped you in
 2 terms of your review of materials and preparation of
 3 your report other -- other than Dr. Hall?
 4 A I had a copy editor -- once I had a draft
 5 of my report -- review it.
 6 Q Who is your copy editor?
 7 A Her name is Chris Tachibana.
 8 Q And where is she employed?
 9 A She is a freelance medical copy editor.
 10 Q What role did she play in your review and
 11 analysis of materials and your -- the preparation of
 12 your report?
 13 A So she played no role in the review -- or
 14 the drafting of the report, but she reviewed a draft
 15 near the end for grammatical issues to remove
 16 redundancy.
 17 She's someone I work with a great deal for
 18 my medical publications, and so --
 19 Q You have worked with her in the past -- I
 20 --
 21 A That's right --
 22 Q -- is that right?
 23 A -- yes.
 24 Q Is she here in the San Francisco area?
 25 A She is not.

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1 Q Where is she located?
 2 A She splits her time between Seattle,
 3 Washington, and Germany.
 4 Q She charges for her services; is that
 5 right?
 6 A She does.
 7 Q Are those charges that you paid or that
 8 were paid by plaintiffs' counsel?
 9 A They have not yet been paid, but the plan
 10 is for her to submit those invoices. And it will
 11 come out of my fees, but will be paid by the
 12 counsel.
 13 Q All right. When you submit invoices,
 14 will -- the charges for the copy editor, will those
 15 be included in your invoice to plaintiffs' counsel?
 16 A My plan is for it to come out of my fee.
 17 So I am paying for it, but it should be literally
 18 paid by counsel, since I'm not able to pay and
 19 deduct taxes or pay taxes or -- or so -- or...
 20 Q All right. You will pay it out of your
 21 pocket and will not include it on your statement to
 22 plaintiffs' counsel; is that right?
 23 A That's correct.
 24 Q Approximately how much have you paid or
 25 will you pay to your copy editor?

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1 A I believe the total is in the ballpark of
 2 about 1,500 or \$1,700.
 3 Q How about Dr. Hall? Are her fees being
 4 paid by you or are they being paid by plaintiffs'
 5 counsel?
 6 A Her fees are being paid by counsel.
 7 Q Dr. Hall either has or will submit her own
 8 separate invoice relating to her work on this
 9 matter?
 10 A Yes.
 11 Q Has she already done that?
 12 A I believe she has submitted it. I -- I'm
 13 not 100 percent sure.
 14 Q Do you know what Dr. Hall's fees are at
 15 least through the present time relating to her work
 16 on this matter?
 17 A I believe the amount is in the ballpark of
 18 the same 1,500 to \$2,000.
 19 Q You believe, though, that Dr. Hall either
 20 has or will be submitting invoice -- an invoice
 21 separately for her work to plaintiffs' counsel; is
 22 that right?
 23 A Yes.
 24 Q You have submitted invoices; is that
 25 right?

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1 A I have.
 2 Q When were you first retained in this
 3 matter -- well, strike that.
 4 When were you first contacted with
 5 respect to this litigation, the talcum powder MDL?
 6 A My recollection is mid-2017.
 7 Q Who contacted you in mid-2017?
 8 A I was initially contacted by a law firm
 9 that I believe was helping the law firms find expert
 10 witnesses and asked if I would be willing to speak
 11 with them to see if this could be something that I
 12 would be interested in doing.
 13 Q What law firm or lawyer contacted you
 14 initially in mid-2017?
 15 A I -- I don't remember that initial
 16 contact.
 17 Q You don't remember the name of the lawyer
 18 or the law firm that initially contacted you in this
 19 matter?
 20 A The initial law firm basically asked me if
 21 I would be willing to speak to these lawyers, and I
 22 do not know the name of that lawyer who originally
 23 contacted me.
 24 Q Did you ever speak to that lawyer again?
 25 A No.

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1 Q What did that lawyer tell you or ask you
 2 about this engagement?
 3 A They told me that there was a -- a case
 4 that they would like some epidemiology research on
 5 and that they thought I would be a very good fit and
 6 would I be willing to speak with them.
 7 I don't believe they even told me what the
 8 content of -- of the case was about, but rather,
 9 that it was a case. And the role that they were
 10 seeking was as an epidemiologist, not as a
 11 radiologist or on the medical care.
 12 Q Was this a phone call or an e-mail or how
 13 did they contact you?
 14 A I believe it was a short e-mail followed
 15 by a short phone call.
 16 Q I mean, do you keep those e-mails? And if
 17 at some point we ask for them to be produced, is
 18 that something you could do?
 19 A For the particular e-mail that you are
 20 asking about, I cannot find it. So I don't have
 21 that. I looked.
 22 Q You were contacted by a lawyer or law
 23 firm, asked if you would be willing.
 24 You said you would be willing without even
 25 knowing what the matter related to?

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1 A I didn't say I would be willing to be an
 2 expert. I said I would be willing to have a
 3 conversation with the lawyers to learn about the
 4 case.
 5 Q Were you told at that time that the case
 6 related to talcum powder?
 7 A I was not.
 8 Q Were you told at that time that the
 9 medical issue in the case related to ovarian cancer?
 10 A I do not believe I was.
 11 Q What is the next contact then that you had
 12 with any lawyer relating to this matter?
 13 A So then a phone call was set up between
 14 myself and, I believe it was, three lawyers involved
 15 in this litigation and told about the -- what the --
 16 what the case was about and told what they were
 17 looking for to see if I would be interested in
 18 speaking with them.
 19 And that lead to an in-person meeting
 20 where we then discussed what the case was about.
 21 Q When was the phone call with the three
 22 attorneys?
 23 A All of this was in mid-2017, June-July
 24 time frame.
 25 Q The same question. When was the in-person

Page 46

1 meeting?

2 A Within that same -- maybe a month later,

3 but same time frame.

4 Q Was the in-person -- strike that.

5 Where was the in-person meeting?

6 A It was in my office in San Francisco.

7 Q Who were the three attorneys that you

8 spoke with initially over the phone and then met

9 with in person?

10 A So Dr. Thompson was one; John Restaino was

11 one; and a third lawyer whose name is alluding me.

12 Q Was it a man or a woman?

13 A A woman.

14 Q Is it a lawyer that you have had any

15 further contact with or communications with?

16 A Yes.

17 Q But you can't remember her name?

18 A I can't. But if we give it a minute, I

19 think I will be able to.

20 Q Well, if you do remember it at some point

21 today, let us know.

22 When you had the phone call with

23 Ms. Thompson and with Mr. Restaino and this third

24 lawyer in the in-person meeting, what did they ask

25 you to do?

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1 A They asked me if I would be willing to do

2 a comprehensive and unbiased review of the

3 literature around talcum powder products and ovarian

4 cancer.

5 Q Did they ask you to do anything else?

6 A Well, they asked if I would be willing to

7 be an expert witness in this case.

8 Q Anything else?

9 A Nothing else that I can recall.

10 Q You said you would do a review of the

11 literature, correct?

12 A I -- yes --

13 Q You --

14 A -- I did.

15 Q -- you said that you would be willing to

16 serve as an expert for Plaintiffs, correct?

17 MS. O'DELL: Object to the form.

18 A I -- I hesitated on the last question

19 because I was very upfront and clear that I was

20 willing to do a review, but that I did not know this

21 field in any great depth and that I would only be

22 interested in doing that if I was permitted to do

23 the review the same as I do in my other scientific

24 work and that I didn't know if my conclusion would

25 support my becoming an expert on their behalf.

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1 Q (BY MR. ZELLERS) You understood they

2 represented the Plaintiffs in this litigation --

3 A Yes.

4 Q -- is that right?

5 A Yes.

6 Q You told them that you would be willing to

7 do the review. You did not at that point agree to

8 serve as an expert witness for the Plaintiffs; is

9 that fair?

10 A That's fair.

11 Q Did you then go and do your review,

12 literature review?

13 A Yes, I did.

14 Q You, at least at that point in time, had

15 never previously done any research or review

16 relating to talcum powder or relating to any

17 potential association between talcum powder,

18 perineal talcum powder use, and ovarian concern; is

19 that right?

20 A That's correct.

21 MS. O'DELL: Object to the form.

22 Q (BY MR. ZELLERS) You went out and reviewed

23 the literature; is that right?

24 A Yes.

25 Q Did plaintiff's counsel, the two lawyers

Page 49

1 that you met -- well, strike that.

2 The three lawyers you met with, did they

3 provide you with some articles to get started with?

4 A They provided access to a database, a

5 Dropbox, where they had a large number of articles

6 that they made available to me.

7 Q You reviewed those articles. Did you then

8 have another meeting or communication with the

9 plaintiffs' lawyers?

10 MS. O'DELL: Object to the form.

11 A I had several meetings with the lawyers

12 over the subsequent year.

13 Q (BY MR. ZELLERS) Eventually were you

14 asked, you know, to render an opinion on a topic or

15 topics?

16 MS. O'DELL: Object to the form.

17 A I -- I was asked to draft a report of my

18 review of the -- the literature and the data that

19 were available.

20 Q (BY MR. ZELLERS) At this time were there

21 any new lawyers that you were meeting with on the

22 plaintiffs' side or was it still the three original

23 lawyers?

24 A They were -- I -- I believe those would

25 be -- I think there was one additional lawyer

Page 50

1 that --

2 Q Do you remember his or her name?

3 A Her name. Breanne was her first name.

4 Q Do you know Breanne's last name?

5 A Maybe Cope or something that's similar to

6 Cope.

7 Q You reviewed the articles. You were asked

8 then by Plaintiffs to write up something relating to

9 the articles; is that right?

10 A Yes.

11 MS. O'DELL: Object to the form.

12 Q (BY MR. ZELLERS) At some point did either

13 you suggest or the plaintiff lawyers ask you to form

14 certain opinions relating to this matter?

15 MS. O'DELL: Object to the form.

16 A I'm not -- I'm not sure what you mean,

17 "form opinions."

18 Q (BY MR. ZELLERS) You met with the lawyers;

19 is that right, after you had done your literature

20 review?

21 A Yes.

22 Q You had not yet agreed to be an expert

23 witness for the Plaintiffs; is that right?

24 A Yes.

25 Q After you had done your literature review,

Page 51

1 did the plaintiffs' lawyer say: Well,

2 Dr. Smith-Bindman, do you have an opinion as to

3 whether or not there's an association between

4 perineal talcum powder use and ovarian cancer?

5 A I don't remember any such conversation.

6 I -- I think from the very beginning the lawyers

7 were guessing that I was going to feel strongly that

8 there's a strong association. So I don't remember

9 being retained as an expert after my report came

10 out.

11 At -- at some point I think it became

12 clear to them when I explained my views that they

13 would like to have me be an expert.

14 But I don't remember a particular

15 conversation where they asked me to -- where they

16 linked my being an expert to the finished product of

17 the report. By the time I drafted the report, they

18 knew that they had wanted me to be an expert in this

19 case.

20 Q All right. At -- at some point after you

21 had reviewed the literature and you sat and you

22 talked with plaintiffs' counsel, you became an

23 expert witness for the Plaintiffs; is that right?

24 A Yes.

25 Q Are you able to time that for us any

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1 better than what you have already done?

2 A No.

3 Q As part of serving as an expert for

4 Plaintiffs, you did an -- either A -- do you call it

5 a systematic review or a meta-analysis? What do you

6 call that?

7 A I call it a systematic review.

8 Q What's the difference between a systematic

9 review and a meta-analysis?

10 A I -- I don't think there's any difference.

11 They're -- they're both trying to describe an

12 unbiased, quantitative review of the medical

13 literature.

14 Q Did -- your systematic review that you

15 did, you did that after you had done this review of

16 the literature, fair?

17 MS. O'DELL: Object to the form.

18 A My systematic review grew out of my

19 reading the literature and realizing that there was

20 a real gap, which I thought needed to be filled.

21 And I chose to do that.

22 Q (BY MR. ZELLERS) I will today, you know,

23 ask you some more detailed questions about that.

24 Let me make sure I have covered by basics here.

25 Your report includes as attachments, a

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1 list of references; is that right?

2 A Yes, it does.

3 Q What is meant to be included in the

4 references that appear and are attached to your

5 report, pages 42 through 47?

6 A Those are references that I have cited

7 specifically in my report.

8 Q In addition along with your report, you

9 provided a curriculum vitae; is that right?

10 A Yes.

11 Q We'll mark that as Exhibit 14.

12 (Exhibit 14 was marked for identification

13 and is attached to the transcript.)

14 MS. O'DELL: Thank you.

15 Q (BY MR. ZELLERS) The curriculum vitae that

16 is attached as -- strike that -- that you provided

17 with your report and that we have marked as

18 Exhibit 14, is that complete and up to date?

19 A Yes, it is.

20 Q Any additions or corrections that need to

21 be made to that?

22 A There are some details of recent

23 publications that are not provided in this, but

24 those are relatively minor changes.

25 Q Are any of -- the details to publications

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1 that you would update your curriculum vitae to, do
 2 any of those relate to this matter or to the
 3 opinions you're giving here today?
 4 A They do not.
 5 Q Deposition Exhibit 15 is also a document
 6 that was provided along with your report. It
 7 appears to be a reliance list; is that right?
 8 MS. O'DELL: Object to the form. Thank
 9 you.
 10 (Exhibit 15 was marked for identification
 11 and is attached to the transcript.)
 12 A Yes, it is.
 13 Q (BY MR. ZELLERS) What is included on the
 14 reliance list which we have marked as a Exhibit 14?
 15 A This is a broad list of --
 16 THE COURT REPORTER: 15.
 17 Q (BY MR. ZELLERS) Oh, I'm sorry. Yes let
 18 me ask that question again.
 19 What documents are listed and included on
 20 the reliance list which we have marked as
 21 Exhibit 15?
 22 A That is a broader list of documents. It
 23 includes documents that I may have read, but I
 24 didn't believe needed to be cited.
 25 It also includes documents that counsel

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1 provided to me that -- that may or may not have been
 2 closely read.
 3 So it includes both articles I know very
 4 many, as well as additional documents I may not have
 5 as deep of a knowledge of.
 6 Q Was -- Deposition Exhibit 15, was that
 7 prepared by you or was that prepared by counsel?
 8 A That was prepared by counsel.
 9 Q Have you reviewed all of the references
 10 and materials that are listed out on Deposition
 11 Exhibit 15?
 12 A I -- I do not know. I would have to go
 13 through them one at a time to know if I had reviewed
 14 all of them.
 15 Q Can you easily tell us which of the
 16 materials listed on Exhibit 15, your reliance list,
 17 were provided by you and which were provided by
 18 counsel?
 19 MS. O'DELL: Objection. Objection to
 20 form. I think the documents and materials
 21 considered -- materials and data considered list.
 22 MR. ZELLERS: Well, there's no caption at
 23 the top. I have tried to be as descriptive as I can
 24 with the witness on it.
 25 MS. O'DELL: I think it's referred to in

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1 the report in that manner, but just to clarify.
 2 A No, I could not easily go through and pick
 3 out which ones were ones that I provided to them or
 4 which ones they provided to me.
 5 Q (BY MR. ZELLERS) All right. Are you aware
 6 -- do you know who Dr. Judith Wolf is?
 7 A No, I do not. I know the name, but not
 8 the person.
 9 Q Are you aware that your reliance list or
 10 additional Materials Considered List, what we have
 11 marked as Exhibit 15, is identical to the Materials
 12 Considered List that was attached to Dr. Wolf's
 13 report?
 14 A I -- I don't know who Dr. Wolf is, nor do
 15 I know her reliance list.
 16 Q All right. Exhibit 15 is a reliance list
 17 or Materials Considered List that was prepared by
 18 counsel for Plaintiffs; is that right?
 19 A It was the list provided to me.
 20 Q You may have reviewed some of these
 21 documents -- or you have reviewed some of these
 22 documents, but potentially not all of these
 23 documents --
 24 MS. O'DELL: Object to the form.
 25 Q (BY MR. ZELLERS) -- fair?

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1 A Yes.
 2 Q Looking at your report, Deposition
 3 Exhibit 2 -- and let me withdraw that.
 4 Have we covered now all of the documents
 5 that you have either reviewed and relied upon in
 6 preparing your opinions in this matter and your
 7 report, which we marked as Exhibit 2, or that were
 8 made available to you and you may or may not have
 9 looked at them?
 10 MS. O'DELL: Object to the form.
 11 A Yes.
 12 Q (BY MR. ZELLERS) Is your report,
 13 Exhibit 2, accurate?
 14 A Yes, it is.
 15 Q Is your report, Exhibit 2, complete, other
 16 than perhaps citing to some of the documents that
 17 you reviewed after preparing your report that we
 18 identified earlier today?
 19 A Yes, it is.
 20 Q There were -- withdraw that.
 21 You have a fee schedule. You're charging
 22 a thousand dollars an hour to review materials and
 23 talk with the lawyers in this matter and provide
 24 opinions; is that right?
 25 A Yes.

<p style="text-align: right;">Page 58</p> <p>1 Q I kind of got sidetracked in terms of 2 asking you about the Plaintiff lawyers that you met 3 with. 4 We had gotten up to your meeting with 5 Ms. Thompson, with Mr. Restaino, with a lawyer 6 perhaps with the first name of Breanne; is that 7 correct? 8 A Yep. 9 Q Have you remembered the fourth lawyer yet? 10 A I -- I have not. Can -- can I call a 11 friend? 12 Q No. No, need to call a friend. 13 What other Plaintiff lawyers have you met 14 with relating to your work as a plaintiff expert for 15 the MDL litigation? 16 A There are no others that I recall. 17 Q We have other lawyers here today. You met 18 them -- 19 A I apologize. 20 Q -- at least in the last day or two? 21 A Yes. 22 Q Well, don't apologize to me. You probably 23 hurt their feelings. 24 Did you meet all of the lawyers who are 25 here today at some point?</p>	<p style="text-align: right;">Page 60</p> <p>1 most of the day yesterday, did you have any other 2 meetings or conversations with the lawyers for the 3 Plaintiffs to prepare for your deposition? 4 A Yes, I did. So today is Thursday. 5 Wednesday, we met for most of the day. And I met 6 with Dr. Thompson for an hour or so on Wednesday as 7 well. 8 Q All right. Any other -- 9 MS. O'DELL: I think the days may be mixed 10 up. You said "Wednesday" twice. 11 A I apologize. So Tuesday, we met at the 12 end of the day for an hour and then most of the day 13 yesterday, Wednesday, and then today. Thank you. 14 Q (BY MR. ZELLERS) Any other meetings or 15 communications with counsel for Plaintiffs to 16 prepare for the deposition here today? 17 A Any other in-person meetings or -- 18 Q Or phone calls in which there was, you 19 know, discussion about preparing for the deposition. 20 A I believe over -- well, I had asked to 21 reschedule this deposition. So there were a couple 22 of e-mails related to that. 23 I also had asked for a couple of 24 additional documents to help ensure that I was 25 seeing all materials that I felt were relevant to</p>
<p style="text-align: right;">Page 59</p> <p>1 A Yes, I did. 2 Q Some of them you have met just in the last 3 couple of days as you prepared for the deposition; 4 is that right? 5 A That's correct. 6 Q Other than the lawyers who are present in 7 the room today for Plaintiffs, have you met with any 8 other lawyers or communicated with any other lawyers 9 that you believe represent the Plaintiffs in this 10 litigation? 11 A I have not. 12 Q What did you do to prepare for your 13 deposition here today? 14 A My primary preparation was to review my 15 report and to reaccess references that I included in 16 my report to make sure that I was aware of the 17 details or -- or relevant... 18 Q What else did you do to prepare for your 19 deposition here today? 20 A I also met with the lawyers yesterday to 21 review the process of the deposition and so forth. 22 Q How long did you meet with the lawyers 23 yesterday? 24 A We met most of the day yesterday. 25 Q Other than meeting with the lawyers for</p>	<p style="text-align: right;">Page 61</p> <p>1 the case. 2 Q Are those the materials that were on 3 Exhibit 3 that we talked about at the very 4 beginning? 5 A Yes, they are. 6 Q Anything else that you did with the 7 lawyers in terms of preparing for your deposition 8 here today? 9 A No. 10 MS. O'DELL: Dr. Smith-Bindman, feel free 11 to testify regarding meetings, when they happened, 12 phone calls, et cetera, but not the substance of 13 those discussions. 14 A Okay. 15 MS. O'DELL: Thank you. 16 Q (BY MR. ZELLERS) Any others? 17 A None that I can remember. 18 Q Ms. Thompson -- did you know Ms. Thompson 19 before she initially called you and then came and 20 sat down to meet with you? 21 A Initially, you -- 22 Q Yes. 23 A -- mean? No, I did not. 24 Q Had you ever worked with Ms. Thompson on 25 any other litigation?</p>

<p style="text-align: right;">Page 62</p> <p>1 A No.</p> <p>2 Q Other than the talcum powder litigation</p> <p>3 that we're here deposing you in, have you worked on</p> <p>4 other litigations for either defendants or</p> <p>5 plaintiffs?</p> <p>6 MS. O'DELL: Other than the ones she has</p> <p>7 testified to?</p> <p>8 Q (BY MR. ZELLERS) Well, other than, yes,</p> <p>9 the cases.</p> <p>10 A No, I have not.</p> <p>11 Q You have served as an expert witness in</p> <p>12 other matters in which you did not provide</p> <p>13 deposition testimony; is that right?</p> <p>14 MS. O'DELL: Object to the form.</p> <p>15 A There are a small number of additional</p> <p>16 medical malpractice cases that I was also involved</p> <p>17 with which would have settled before I was asked to</p> <p>18 take a deposition.</p> <p>19 Q (BY MR. ZELLERS) My question is: Have you</p> <p>20 ever testified or consulted with either plaintiffs</p> <p>21 or defense in -- in a product liability litigation</p> <p>22 like this?</p> <p>23 A I have not.</p> <p>24 Q Have you ever provided testimony in a</p> <p>25 matter relating to a consumer product?</p>	<p style="text-align: right;">Page 64</p> <p>1 Q Do the invoices go through the time that</p> <p>2 you prepared your opinions and report as of</p> <p>3 November 15 of 2018?</p> <p>4 A Yes, they will.</p> <p>5 Q All right. Is that where they end?</p> <p>6 A They would also include some hours that I</p> <p>7 have worked reviewing the material since that time.</p> <p>8 Although, I don't believe I have submitted those</p> <p>9 reports -- those invoices, but I certainly can.</p> <p>10 Q So my question is: How much time have you</p> <p>11 spent on this matter since your last invoice? Can</p> <p>12 you estimate that for us?</p> <p>13 A I would guess in the ballpark of 10 hours,</p> <p>14 not including the time I met with the lawyers</p> <p>15 yesterday -- not this week. Excluding the time this</p> <p>16 week.</p> <p>17 Q How much time did you spend this week in</p> <p>18 addition to that 10 hours with the lawyers in</p> <p>19 preparing yourself to provide deposition testimony?</p> <p>20 A In the ballpark of another 10 hours.</p> <p>21 Q Have you been served or been asked to</p> <p>22 serve as an expert witness or consultant in any</p> <p>23 other talcum powder litigation or matters?</p> <p>24 A I have not.</p> <p>25 Q What percent of your professional time do</p>
<p style="text-align: right;">Page 63</p> <p>1 A I have not.</p> <p>2 Q Have you ever been retained as an expert</p> <p>3 or provided testimony in a matter relating to</p> <p>4 asbestos?</p> <p>5 A I have not.</p> <p>6 Q Mr. Restaino -- had you ever met</p> <p>7 Mr. Restaino before that initial phone call and</p> <p>8 meeting back in mid-2017?</p> <p>9 A I had not.</p> <p>10 Q When I look at your invoices, will they</p> <p>11 generally outline the times that you had meetings</p> <p>12 and communications with Plaintiff lawyers?</p> <p>13 A Yes, they will.</p> <p>14 Q Will they also outline whatever work</p> <p>15 that -- and I don't mean work, but at least dates as</p> <p>16 to when you began your systematic review or</p> <p>17 meta-analysis?</p> <p>18 A The work that I did will be itemized. I'm</p> <p>19 not sure if I break down writing the report versus</p> <p>20 doing the systematic review into separate buckets,</p> <p>21 but it might.</p> <p>22 Q The invoices will start with sometime in</p> <p>23 mid-2017, when you started meeting with the lawyers;</p> <p>24 is that right?</p> <p>25 A Yes.</p>	<p style="text-align: right;">Page 65</p> <p>1 you spend working as a consultant?</p> <p>2 A A small amount. Probably less than</p> <p>3 5 percent.</p> <p>4 Q What percent of your income is from</p> <p>5 consulting on litigation matters?</p> <p>6 MS. O'DELL: For a particular year or time</p> <p>7 period or average, just --</p> <p>8 Q (BY MR. ZELLERS) Well, the last couple of</p> <p>9 years.</p> <p>10 A In the last couple of years, a -- a small</p> <p>11 amount. Probably 5 or 10 percent.</p> <p>12 Q What is the largest percent of your income</p> <p>13 that has related to consulting on litigation</p> <p>14 matters?</p> <p>15 And what I'm asking you to do is to look</p> <p>16 back. And what was the high point in terms of</p> <p>17 income that you received from consulting on</p> <p>18 medical/legal matters?</p> <p>19 A Probably the 10 percent that I cited.</p> <p>20 Q Have you ever attended a convention or a</p> <p>21 meeting with plaintiff lawyers and other plaintiff</p> <p>22 experts?</p> <p>23 A I have not.</p> <p>24 Q Never?</p> <p>25 A A meeting of lawyers?</p>

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1 Q Yes, a meeting of lawyers --
2 A Never.
3 Q -- and plaintiff experts.
4 A Never.
5 Q All right. Have you --
6 A I didn't know there was such a thing.
7 Q Do you know any of the experts that have
8 also been retained by the Plaintiffs in this
9 litigation?
10 A I don't know them personally, but I -- I
11 have seen their names. And their names are the
12 same -- some of the names are names that are
13 familiar to me.
14 Q Have you communicated with any of the
15 other experts for Plaintiffs?
16 A I have not.
17 Q Have you reviewed reports from any of the
18 experts for Plaintiffs?
19 A I have reviewed a handful of them --
20 Q What --
21 A -- yes.
22 Q -- reports of other plaintiff experts have
23 you reviewed?
24 A I reviewed Dr. Cooke's report. I reviewed
25 Mr. Longo's report. I reviewed an ob --

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1 obstetrician gynecologist report.
2 Q Do you remember who?
3 A Clarke perhaps or something like Clarke.
4 MS. O'DELL: If you need to refer to your
5 report or your materials, feel free to do that.
6 A Okay. I think Mr. Cralley's (phonetic)
7 report.
8 Q (BY MR. ZELLERS) Do you know any of those
9 experts personally?
10 A I do not.
11 Q All right. You have never communicated
12 with any of those experts; is that right?
13 A I have not.
14 Q You have just reviewed their reports; is
15 that right?
16 A That's correct.
17 Q Have you reviewed any deposition testimony
18 or portions of depositions of plaintiff experts in
19 this matter?
20 A I have reviewed small pieces of several of
21 them.
22 Q Okay. What experts have you reviewed a --
23 small pieces of their deposition?
24 A Dr. Moorman's testimony or deposition, I
25 saw some of.

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1 Q What others?
2 A Mr. Cooke's deposition, I believe.
3 Q What others? Did you put in your report,
4 the names of other experts that you reviewed their
5 deposition testimony of?
6 A I -- I -- I'm checking if -- if I have.
7 I...
8 Q Well, you have a recollection of reviewing
9 --
10 A -- I -- I don't have a recollection of any
11 others that I have looked at.
12 Q Do you know who David Kessler is?
13 A I do.
14 Q How do you know Dr. Kessler?
15 A I --
16 MS. O'DELL: Object to the form.
17 A -- Dr. Kessler is a faculty member at
18 UCSF.
19 Q (BY MR. ZELLERS) Do you know him
20 personally?
21 A Not well, but enough to say hello.
22 Q Been at meetings with him?
23 A I have.
24 Q You understand that he's an expert for the
25 Plaintiffs?

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1 A I -- I have been told that.
2 Q Have you had any discussions with
3 Dr. Kessler at all relating to this matter, the
4 talcum powder matter?
5 A I have not.
6 Q Have you participated in any projects --
7 medical/legal projects with Dr. Kessler --
8 A I --
9 Q -- in the past?
10 A -- I have not.
11 Q Have you heard of a documentary called
12 "The Bleeding Edge"?
13 A I have.
14 Q Did you participate in the documentary
15 called "The Bleeding Edge"?
16 A I did.
17 Q You understand that Dr. Kessler also
18 participated in that; is that right?
19 A I -- yes.
20 Q That is a documentary related to what?
21 A A medical devices, primarily.
22 Q Have you served as a consultant or expert
23 in medical device matters?
24 A I have not.
25 Q Pharmaceutical matters?

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1 A I have not.

2 Q How was it then that you were retained or

3 ended up participating in "The Bleeding Edge"

4 documentary?

5 MS. O'DELL: Object to the form.

6 A I -- I'm not sure if you have had a chance

7 to see the documentary or not, but my role in it

8 is -- is pretty off topic.

9 And so at an initial incarnation of that

10 documentary, they had thought about focusing on an

11 issue where I do do research, radiation for medical

12 imaging.

13 It no longer fits into their new topic,

14 but somehow they kept a quote of me in that film.

15 Q Did -- Dr. Kessler, was he the one

16 responsible for putting that documentary together?

17 A I -- no, I don't -- I don't believe he

18 was.

19 Q Were you paid for your work in

20 participating in that documentary?

21 A No I was not.

22 Q All right. Jane Hall, she assisted you

23 with your systematic review. Is -- is that the

24 right way you would characterize it, a systematic

25 review?

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1 A Yes, the systematic review -- you asked

2 the difference between a meta-analysis. It sort of

3 implies a certain scientific review -- rigor when

4 you call it a systematic review, so that's how I

5 like to think about it.

6 Q You think systematic review implies more

7 scientific rigor than meta-analysis?

8 A I think it's a subtle distinction, but

9 yes, I do.

10 Q Well, you communicated and hired Jane hall

11 to assist you; is that right?

12 A Yes, I did.

13 Q Have you produced all of your

14 communications and materials with Jane Hall?

15 A I have.

16 Q How did you come in contact with Dr. Hall?

17 A I work closely with an emergency medicine

18 researcher, and I have assisted him in several

19 systematic reviews.

20 And I knew he had a biostatistician who

21 generated the kind of graphics and analysis that I

22 wanted. And so I reached out to him, and he

23 introduced me to Dr. Hall.

24 Q You had never worked with Dr. Hall prior

25 to performing your systematic review --

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1 A I had --

2 Q -- in this case --

3 A -- not.

4 Q -- is that right?

5 A That's correct.

6 Q Have you worked with other

7 biostatisticians in the past?

8 A I have.

9 Q Why did you decide you needed to work with

10 a new biostatistician for this litigation?

11 A The primary work that I needed was to do a

12 few graphs and figures, and so I wanted someone who

13 was both an expert in that and who I thought could

14 respond relatively quickly.

15 I have on my team, several

16 biostatisticians who are part of my research group,

17 but they don't have particularly relevant expertise

18 in generating these graphs.

19 And it would have required them to acquire

20 some skills, and so I wanted someone who focuses

21 specifically on this who could do that.

22 Q Did you review any work from Dr. Hall

23 before you hired her?

24 A I have been involved in systematic reviews

25 that she contributed to that I was very impressed

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1 with. And so --

2 Q So what other --

3 A -- I reached out.

4 Q -- sorry. I didn't mean to interrupt you.

5 What other systematic reviews have you

6 been involved with Dr. Hall?

7 A Actually, two of them. One of them is on

8 a treatment for kidney stones. Ralph Wang is the

9 senior author.

10 And the second was a systematic review

11 around the diagnosis of and treatment for pulmonary

12 embolism that also Dr. Wang was the leader on.

13 Q Did you ever meet with Dr. Hall with

14 respect to this work in person?

15 A I never met with her related to anything.

16 It was all by electronic communication.

17 Q Did you ever talk with her over the phone?

18 A Yes. We spoke a few times.

19 Q Did you take notes of your conversations

20 with Dr. Hall?

21 A Not that I recall.

22 Q You did have e-mails with Dr. Hall --

23 A Yes.

24 Q -- is that right?

25 A Yes.

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1 Q Do you have receipts for the work that
2 Dr. Hall performed for you?
3 MS. O'DELL: Object to the form.
4 A Like an invoice receipt?
5 Q (BY MR. ZELLERS) Yes, an invoice receipt.
6 A No, I do not.
7 Q You ended up paying her rush fees so that
8 she would do the work and the analysis more quickly;
9 is that right?
10 MS. O'DELL: Object to the form.
11 A I -- I remember telling her I didn't mind
12 her rush fee. But -- but all of the invoicing was
13 done directly with counsel.
14 Q (BY MR. ZELLERS) Well, Dr. Hall came to
15 you and said: You know, it's going to take X amount
16 of time to do a thorough analysis?
17 A Yes.
18 Q She did offer to rush the analysis --
19 A Yes.
20 Q -- when you told her you needed it?
21 A Yes.
22 Q And your recollection is she, you know,
23 did rush the analysis and -- and got it done within
24 a couple of days?
25 MS. O'DELL: Object to the form.

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1 A I believe the analysis actually took a
2 couple of weeks.
3 But I was very open to paying her rush
4 fee. I thought her fee was extraordinarily
5 reasonable, and so it just made it easier for me to
6 get it done quickly rather than to delay.
7 Q (BY MR. ZELLERS) You defer to the e-mails
8 and the documents as to the timing of when you
9 requested that she rush the analysis and when she
10 provided it to you; is that right?
11 MS. O'DELL: Object to the form.
12 A I believe my documents would be correct
13 about when I asked for stuff and when it was done,
14 yes.
15 MS. O'DELL: Excuse me, Mike. We have
16 been going about an hour and 20 minutes. Is this a
17 good time to take a quick break?
18 MR. ZELLERS: Absolutely.
19 THE VIDEOGRAPHER: We are off the record.
20 The time is 10:40 a.m. This is the end of Disc 1.
21 (A break was taken from 10:40 a.m. to
22 11:10 a.m.)
23 THE VIDEOGRAPHER: We are back on the
24 record. This marks the beginning of Disc No. 2 in
25 the deposition of Dr. Rebecca Smith-Bindman. The

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1 time is 11:10 a.m.
2 Q (BY MR. ZELLERS) Dr. Smith-Bindman, I'm
3 handing you Deposition Exhibit 16, which is an
4 e-mail chain. The very first e-mail, meaning the
5 last e-mail at the top of page 1, is Jane Hall --
6 from Jane Hall, September 24, 2018, at 8:04 a.m. to
7 you.
8 (Exhibit 16 was marked for identification
9 and is attached to the transcript.)
10 Q (BY MR. ZELLERS) Will you take a look at
11 that and tell us if that is a printout of some of
12 your e-mail exchanges with Dr. Hall?
13 A Yes.
14 Q If we go to the very first e-mail in the
15 chain, it appears that you contacted Dr. Hall on
16 Wednesday, September 19, 2018, in the afternoon,
17 3:21 p.m., and told her that you were interested
18 primarily in generating a forest plot with a summary
19 estimate and test for heterogeneity; is that right?
20 A Yes.
21 Q That was your initial contact with
22 Dr. Hall; is that right?
23 A Yes.
24 Q You contacted your referring person,
25 Ralph, on the e-mail; is that right?

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1 A Yes.
2 Q All right. You told -- the next day you
3 had some exchanges of e-mails with Dr. Hall. You
4 told Dr. Hall that because you were doing a review
5 for a legal case, you did not need the detail that
6 you would need for a paper; is that right?
7 MS. O'DELL: Object to the form.
8 A Can you tell me where you're reading?
9 Q (BY MR. ZELLERS) Sure. I'm reading on
10 page 2 of Exhibit 16, the very last e-mail. This is
11 from you on September 20 of 2018.
12 You thanked Dr. Hall for her willingness
13 to help.
14 "As Ralph mentioned, I am doing a review
15 for a legal case and don't need quite the detail I
16 would usually need for a paper."
17 Is that what you told Dr. Hall?
18 A Yes, it is.
19 Q As of -- well, you communicated with
20 Dr. Hall on Friday, September 21st, in the
21 morning. This is the very last e-mail on page 1 of
22 Exhibit 16.
23 You asked her to send you whatever she was
24 doing sooner rather than later because you needed to
25 get your report finished ASAP; is that right?

<p style="text-align: right;">Page 78</p> <p>1 MS. O'DELL: Object to the form. I think 2 you misstated date on the e-mail but -- 3 Q (BY MR. ZELLERS) Well, I'm sorry. Let me 4 ask that question again. On Friday morning, 5 September 21, 2018, you told Dr. Hall that you 6 needed her information as soon as possible because 7 you had to finish your report ASAP; is that right? 8 A Yes. 9 Q Dr. Hall got back to you that day and 10 said, you know, I'll do my best. But if you want, I 11 can rush the work, if you're willing to pay time and 12 a half. 13 You then got back to her on Monday 14 morning, September 24, and said: Yes, I'll pay the 15 rush fee, and I would like your work as soon as 16 possible. 17 Is that right? 18 MS. O'DELL: Object to the form. Object 19 to the form. 20 A I -- I think you're paraphrasing what it 21 says. The -- the idea was she said that if I paid 22 the rush, she could have some money to defray 23 childcare cost during -- 24 Q (BY MR. ZELLERS) Right. And -- 25 A -- that time, and I agreed to do that.</p>	<p style="text-align: right;">Page 80</p> <p>1 A Yes. 2 Q Have you communicated about this 3 litigation with anyone other than the plaintiffs' 4 counsel that you have told us about with Dr. Hall? 5 Anyone else? 6 MS. O'DELL: Object to the form. 7 A I -- you asked me if I have mentioned this 8 litigation to anyone else? 9 Q (BY MR. ZELLERS) Well, let's start there. 10 Have you mentioned this litigation to anyone else? 11 A I have. 12 Q Who have you mentioned this litigation to? 13 A I have certainly mentioned it to my 14 husband. 15 Q Other than your husband? 16 A And then I have mentioned it to several 17 close friends. 18 Q Your husband is a physician; is that 19 right? 20 A He is. 21 Q Did he provide any professional input to 22 you related to your review of this matter? 23 A No, he did not. 24 Q The close friends that you mentioned this 25 to, did they provide any input or assistance or</p>
<p style="text-align: right;">Page 79</p> <p>1 Q Exactly. And she said back to you: Okay. 2 By the end of -- so this is on a Monday. She said 3 you'll have the work product from her Wednesday at 4 the earliest, probably Thursday. 5 "I should have at least two sets of plots 6 today, and I'll send them to you as they are 7 output." 8 Is that right? 9 A Yes. 10 Q You have produced all of your e-mails and 11 communications with Dr. Hall in this matter; is that 12 right? 13 A I have. You're not showing me all of 14 those communications; is that right? 15 Q I haven't yet. 16 A Okay. 17 Q I'm going to show you some more. 18 A Yes. 19 Q But my question to you is: Included in 20 the production, at least you have included all of 21 your communications -- 22 A Yes. 23 Q -- with Dr. Hall -- 24 A Yes. 25 Q -- is that right?</p>	<p style="text-align: right;">Page 81</p> <p>1 direction to you relating to this matter? 2 A No. 3 Q I asked you before if you read any of the 4 depositions of the plaintiff experts. Have you 5 discussed generally with plaintiffs' counsel, the 6 deposition testimony that's been given by other 7 plaintiff experts in this litigation? 8 MS. O'DELL: I would instruct you not to 9 answer that question. 10 MR. ZELLERS: I disagree, but we'll 11 reserve that issue. 12 Q (BY MR. ZELLERS) Was there anything that 13 you asked plaintiffs' counsel to provide to you in 14 connection with your review or for preparation of 15 your report that you were not provided with? 16 A So most of the documents that I included 17 in my report, I found by doing an independent search 18 online. 19 There were several items that I didn't 20 find that I wanted to review as well. And so some 21 of the items that I asked counsel for were items 22 that I couldn't find through scientific research 23 that I asked them to provide. 24 Q And you have told us about those 25 documents, and those are listed out on Exhibit 3; is</p>

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1 that right?

2 A That's correct.

3 Q My question was a little bit different.

4 Is there anything that you asked for from

5 plaintiffs' counsel that they were not able or did

6 not provide to you?

7 MS. O'DELL: Object to the form.

8 A I -- I can't think of anything that fits

9 into that question.

10 Q (BY MR. ZELLERS) Take a look at your

11 reliance list, which we have marked as Deposition

12 Exhibit 15.

13 Do you have that in front of you?

14 A I have my copy of the reliance list. I

15 don't have your Exhibit 15 in front of me.

16 Q If you have your copy -- does it start

17 with page 1?

18 A Yes, it does.

19 Q At the very top --

20 A Yes.

21 Q -- the first item is "A Survey of The

22 Long-Term Effects"?

23 A Yes.

24 Q If you turn to pages 11 and 12, there's a

25 series of documents that begin with "IMERY'S"

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1 followed by numbers.

2 Do you see that?

3 A I do.

4 Q Do you know whether or not you reviewed

5 some or all of those Imerys-produced documents as

6 part of your review in this matter?

7 A If those reflect Imerys testing documents

8 then yes, I did review at least some of them. I

9 can't be sure all of them.

10 Q Do you know whether or not these documents

11 relate to Imerys testing?

12 A I have reviewed at least a half dozen

13 Imerys testing documents.

14 Q In --

15 A I believe that's what these are, but I --

16 I'm not sure.

17 Q There are a number of Imerys documents

18 that are listed on Exhibit 3, which you identified

19 as testing documents; is that right?

20 A Yes.

21 Q Do you know if you reviewed any Imerys

22 documents other than the documents that are listed

23 out on Exhibit 3?

24 MS. O'DELL: Can you just make a --

25 Exhibit 3, would you remind --

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1 MR. ZELLERS: Sure. Exhibit 3 is the list

2 you gave me today of -- of the documents that

3 Dr. Smith-Bindman reviewed in addition to whatever

4 else is marked.

5 MS. O'DELL: -- I see. I see.

6 MR. ZELLERS: So there's a -- it's a list

7 of Bates-stamped documents.

8 MS. O'DELL: Yes.

9 MR. ZELLERS: There's 10 or 12 Imerys

10 documents. There's one J&J Bates-stamped document

11 --

12 MS. O'DELL: Right.

13 MR. ZELLERS: -- and then there's the, I

14 think, expert report or --

15 MS. O'DELL: Right.

16 MR. ZELLERS: -- deposition of Dr. Cooke

17 listed?

18 MS. O'DELL: Right. Okay. I just object

19 to the form of the question. And -- and --

20 A Could I --

21 MS. O'DELL: -- then --

22 A -- see Exhibit 3?

23 MS. O'DELL: -- yes. And then I would --

24 Counsel, permit me -- there was a question related

25 to Exhibit 3. I thought you were referring to the

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1 materials list, and so I'm going to assert my

2 objection a little bit late.

3 MR. ZELLERS: Okay. I just want to move

4 forward.

5 MS. O'DELL: I know that you do.

6 MR. ZELLERS: Yes.

7 MS. O'DELL: I just want to be clear.

8 Because Exhibit 3 that we provided were additional

9 materials that Dr. Smith-Bindman asked for and

10 reviewed in addition to the Materials Considered. I

11 don't want the record to be unclear. So --

12 MR. ZELLERS: Well --

13 MS. O'DELL: -- I have noted my objection.

14 MR. ZELLERS: -- and the record is clear

15 that Dr. Smith-Bindman did not review all of the

16 materials listed in the Materials Considered List,

17 Exhibit 15. But that testimony will stand as it is.

18 My question just is: In addition to the

19 documents that I was told about this morning that

20 you believe are testing documents, do you know

21 whether you reviewed any other Imerys-produced

22 documents, and specifically the ones that are

23 itemized on pages 11 and 12 of your Materials

24 Considered List?

25 A I would need to see those documents to

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1 know if I reviewed them. The names are awfully
 2 nonspecific.
 3 Q With respect to the Imerys documents -- or
 4 Imerys-produced documents that are identified in
 5 Exhibit 15, which is your Materials Considered List,
 6 do you know how those were compiled?
 7 MS. O'DELL: Object to the form.
 8 A You're asking me where this list came
 9 from?
 10 Q (BY MR. ZELLERS) I think you have told us
 11 the list came from plaintiffs' counsel; is that
 12 right?
 13 A Yes.
 14 Q My question then, I guess, is more
 15 precise. Do you know how plaintiffs' counsel
 16 compiled this list of Imerys-produced documents or
 17 how they selected those documents?
 18 A I know I had a lot of back and forth in
 19 generating this list with actually Breanne at the
 20 time. I sent her a lot of documents that I had
 21 looked at that I hadn't cited that she added to the
 22 list.
 23 These were ones that she added to the
 24 list, and I don't remember what they were.
 25 Q I'm going to ask my question again. Do

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1 you know how -- these documents, the documents that
 2 are on pages 11 and 12 of your Materials Considered
 3 List that begin with the "Imerys" name, do you know
 4 how they were compiled?
 5 A No.
 6 Q All right. The same question. If you
 7 look on page 13 of your Materials Considered List,
 8 there's a series of documents that have J&J and then
 9 a number; is that right?
 10 A Yes.
 11 Q You, as we sit here, do not know what
 12 those documents relate to; is that right?
 13 A That's correct.
 14 MS. O'DELL: Object to the form.
 15 Q (BY MR. ZELLERS) You do not know how this
 16 listing of J&J documents was compiled; is that
 17 right?
 18 A That's correct.
 19 Q These are documents produced by Imerys and
 20 by Johnson & Johnson companies as part of this
 21 overall list of materials that were available, you
 22 know, for you to review; is that right?
 23 MS. O'DELL: Object to the form.
 24 A Yes.
 25 Q (BY MR. ZELLERS) Outside of your work in

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1 litigation -- so when you do your research work or
 2 when you do your publishing work -- do you rely on
 3 documents that are picked by someone else that may
 4 not represent the full body of evidence?
 5 MS. O'DELL: Object to the form.
 6 A In my work, I review whatever data are
 7 available. And sometimes those data are identified
 8 by me and sometimes they have been given to me by
 9 other sources to review.
 10 Q (BY MR. ZELLERS) Is that a -- a yes or a
 11 no? And let me withdraw that.
 12 The documents that we have looked at in
 13 your reliance list Materials Considered List that
 14 begin with Imerys and begin with J&J, your
 15 understanding, those are documents that have been
 16 produced by the Defendants in this litigation; is
 17 that right?
 18 A Yes.
 19 Q Do you know what percentage of the overall
 20 documents that have been produced by Johnson &
 21 Johnson companies and by Imerys, these documents
 22 that are listed in Exhibit 15, represent?
 23 MS. O'DELL: Object to the form.
 24 A Are you asking me if the handful of
 25 documents from Johnson & Johnson that are in this

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1 list reflect all of the documents ever created at
 2 Johnson & Johnson or all relevant documents or --
 3 Q (BY MR. ZELLERS) Do you have any idea?
 4 A No, no idea.
 5 Q This is a handful of documents that have
 6 been listed out by plaintiffs' counsel for you; is
 7 that right?
 8 A Yes.
 9 MS. O'DELL: Object to the form.
 10 A Yes.
 11 Q (BY MR. ZELLERS) All right. In your
 12 report you cite two exhibits from the depositions of
 13 several witnesses. There's an exhibit from a
 14 deposition of John Hopkins.
 15 Do you know who John Hopkins is?
 16 A I know what the document is, but I -- I
 17 don't know what -- who John Hopkins is.
 18 Q Do you know what company he works for?
 19 A I do not.
 20 Q Do you know what his position or title is?
 21 MS. O'DELL: Object to the form.
 22 Q (BY MR. ZELLERS) You're looking in your
 23 materials at the exhibit that you were provided from
 24 his deposition; is that right?
 25 A Yes. I -- I -- I do not --

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1 Q Have --
2 A -- see.
3 Q -- you read any portion of the deposition
4 of John Hopkins?
5 A I have not.
6 Q Have you reviewed any other exhibits from
7 the deposition of John Hopkins?
8 A I have not.
9 Q Do you know who Julie Pier is?
10 A I believe I do.
11 Q Who is Julie Pier?
12 A I -- I'm just checking. I -- I -- I got a
13 few names wrong earlier, so I want to just check
14 if --
15 Q Well, you're going back now and you are
16 looking at your report?
17 A Yes.
18 Q And you have annotated your report, I
19 guess, that you are using here today; is that right?
20 A Yes.
21 Q Why don't we -- just so we have a complete
22 record, we'll mark your annotated report as
23 Exhibit 17.
24 A Yes.
25 (Exhibit 17 was marked for identification

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1 and is attached to the transcript.)
2 A And -- and I would like to clarify based
3 on some of my notes. But -- so I think Dr. Hopkins
4 oversaw testing for -- for talc products at J&J.
5 Q (BY MR. ZELLERS) Is that a note that you
6 have on your report?
7 A It is.
8 Q All right. That's a note that you put on
9 your report in preparation for your deposition
10 today?
11 MS. O'DELL: Object to the form.
12 A It's a note I put on my report when I was
13 reviewing my report and the documents I'm citing and
14 so forth.
15 Q (BY MR. ZELLERS) Who is Julie Pier? Do
16 you know who she is?
17 A I'm -- what I believe -- although, I don't
18 see that I made a note of it -- is that she was
19 someone who did testing from one of the New York
20 hospitals of -- of the talc powder products.
21 Q Do you know anything more than that about
22 Julie Pier or who she worked for or what her role
23 with respect to talcum powder was?
24 A Now that I am remembering where I -- I --
25 no, I don't really know those things.

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1 Q All right. You were provided -- just as
2 you were for the exhibit from the deposition of John
3 Hopkins, you were provided with the exhibit that you
4 are reviewing from Julie Pier's deposition; is that
5 right?
6 MS. O'DELL: Object to the form.
7 A No, I don't -- well, I -- I don't believe
8 that's why I know who she is.
9 I -- I believe The New York Times story
10 and the Reuters story discussed her deposition. So
11 I don't remember reading her deposition. But I --
12 if I'm not confusing her with someone else, I think
13 that's where I learned about her testing.
14 Q (BY MR. ZELLERS) Okay. You're a couple of
15 questions ahead of me here. No. 1, the exhibit
16 that's in your blue folder from the deposition of
17 Julie Pier, that was provided to you for review by
18 counsel for Plaintiffs; is that right?
19 A Thank you for that reminder. That's the
20 Imerys document. Yes. Yes.
21 Q I'm going to go back to my question.
22 A Yes.
23 Q The exhibit from Julie Pier's deposition,
24 that was provided to you for review by plaintiffs'
25 counsel; is that right?

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1 A Yes.
2 MS. O'DELL: Object to the form.
3 Q (BY MR. ZELLERS) You have not reviewed the
4 deposition transcript of Ms. Pier; is that right?
5 A Not that I recall.
6 Q You have not reviewed any exhibit -- other
7 exhibits to her deposition; is that right?
8 A That is correct.
9 Q Are you aware that the two exhibits that
10 you were provided by counsel for Plaintiffs -- one
11 from the deposition of John Hopkins and one from the
12 deposition of Julie Pier -- that those exhibits were
13 prepared by plaintiffs' experts for this litigation?
14 MS. O'DELL: Object to the form. I think
15 you referred to plaintiffs' experts. I think you
16 misspoke. You said they were prepared by
17 plaintiffs' experts.
18 MR. ZELLERS: Well -- and I will ask it
19 again then.
20 Q (BY MR. ZELLERS) Are you aware that the
21 exhibits that were provided to you -- one from
22 Ms. Pier's deposition and one from the Hopkins
23 deposition -- are exhibits that were prepared by
24 Plaintiffs in this litigation?
25 MS. O'DELL: Object to the form.

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1 A I was provided these documents from a
2 prior case. I don't know who prepared them or where
3 they came from. I -- they were provided to me by
4 counsel.
5 Q (BY MR. ZELLERS) Let me ask you just a
6 couple of background questions from your review of
7 the literature in this case. You have reviewed a
8 lot of literature relating to talcum powder and
9 talcum powder use by women in the perineal region;
10 is that right?
11 A Yes, I have.
12 Q I think you say in your report that you
13 reviewed upwards of 40 studies in papers relating to
14 that. Does that sound about right?
15 MS. O'DELL: Object to the form.
16 A Upward of 40 studies that provided primary
17 new data. There were probably hundreds of papers I
18 reviewed on the topic.
19 Q (BY MR. ZELLERS) From that review, do you
20 agree that most women who use talcum powder in their
21 perineal region begin that use before age 30?
22 A I don't know the -- when -- I -- I think a
23 lot of women start use when they're young. I would
24 have to check my report if I have cites as to when
25 they began using talcum powder products.

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1 Q (BY MR. ZELLERS) Well, take a look, if you
2 will, at Deposition Exhibit 18, which is a report by
3 Cramer.
4 (Exhibit 18 was marked for identification
5 and is attached to the transcript.)
6 Q (BY MR. ZELLERS) He's the first named
7 author. This is the 2016 study --
8 MS. O'DELL: Thank you.
9 Q (BY MR. ZELLERS) -- report. Are you --
10 MS. O'DELL: Are we at 18?
11 MR. ZELLERS: 18.
12 Q (BY MR. ZELLERS) You're familiar with the
13 paper we have marked as Deposition Exhibit 18; is
14 that right?
15 A Yes, I am.
16 Q I do want to ask you questions a later
17 about that. But for purposes of this question when
18 do most women who use talcum power -- powder in
19 their perineal region begin, go to page 336 of
20 Exhibit 18 and specifically Table 1.
21 A Yes.
22 Q One of the categories that is reported
23 here in Table 1 is "Age First Used Genital Powder";
24 is that right?
25 A Yes.

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1 Q And if we looked at the data for when and
2 the age that women were when they first used genital
3 powder, at least from this study by Dr. Cramer, it
4 appears that the vast majority of women began using
5 talcum powder in their genital area before age 30;
6 is that right?
7 A In this publication.
8 Q Do you recall any other publications
9 that -- that you reviewed that provided contrary
10 information?
11 A The question you're asking me is not one
12 that I spent a lot of time thinking about and so
13 can't recall -- sort of across the hundreds of
14 papers I read and 50 that talked about the
15 association -- what time the age of first use was.
16 I -- I see Dr. Cramer's experience is that
17 women do report beginning use earlier, but I --
18 there's no way for me to know if that's a reflection
19 of his sampling, the place he studied the women, and
20 so forth.
21 Q At least on that point, you would refer to
22 Dr. Cramer, fair?
23 MS. O'DELL: Object to the form.
24 A I -- I would defer to a comprehensive
25 review of the literature to come up with that view.

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1 My -- my guess would be that Dr. Cramer
2 believes his numbers in his population, but I -- but
3 I don't know that that's the truth in other
4 populations.
5 Q (BY MR. ZELLERS) Well, let me ask you
6 another question. On average from the studies that
7 you reviewed, do women who use talcum powder in
8 their perineal region continue that use for over
9 20 years?
10 MS. O'DELL: Object to the form.
11 A My recollection of the literature is that
12 most publications could not assess or did not ask in
13 detailed enough form of how long women used it.
14 I -- I -- again, it's possibly a question
15 that could be answered from the literature, but I
16 don't recall knowing that answer from my review of
17 the literature.
18 Q (BY MR. ZELLERS) Did you review the Wu
19 2015 paper?
20 A I did.
21 Q Do you have that in one of your notebooks?
22 A I will have it in here.
23 Q That makes it easy.
24 A 2009 or --
25 Q '15. No. The 2015 Wu paper.

<p style="text-align: right;">Page 98</p> <p>1 A Yes, I do.</p> <p>2 Q Turn to page 1097, Table 2.</p> <p>3 A Could you -- unfortunately, the page --</p> <p>4 the version I have is a free download, and it</p> <p>5 doesn't have the same page --</p> <p>6 Q How --</p> <p>7 A -- numbers.</p> <p>8 Q -- about -- can you find Table 2? It's</p> <p>9 the a table that's captioned "Prevalence of Risk</p> <p>10 Factors in Non-Hispanic white, Hispanic, and</p> <p>11 African-American Control."</p> <p>12 A Yes, I have that paper.</p> <p>13 Q All right. So if you look at the</p> <p>14 controls, at the very bottom of that section, it</p> <p>15 gives a mean number of years of talc use among</p> <p>16 users; is that right?</p> <p>17 A Yes.</p> <p>18 Q And whether we're looking at non-Hispanic</p> <p>19 whites, Hispanics, or African-Americans, at least</p> <p>20 the number of years of talc use that's reported is</p> <p>21 greater than 20 years for each of those groups; is</p> <p>22 that right?</p> <p>23 A In --</p> <p>24 MS. O'DELL: Object to the form.</p> <p>25 A -- in Dr. Wu's paper, there is reported</p>	<p style="text-align: right;">Page 100</p> <p>1 A Yes.</p> <p>2 Q (BY MR. ZELLERS) Are you able to tell us</p> <p>3 how far before you prepared your report, November 15</p> <p>4 of 2018, that you formed those conclusions?</p> <p>5 MS. O'DELL: Object to the form.</p> <p>6 A I spent considerable hours during 2018</p> <p>7 reviewing the literature. And over the course of</p> <p>8 that year, my opinions started to solidify when I</p> <p>9 saw the evidence that strongly supported that</p> <p>10 ovarian cancer is caused by talcum powder products.</p> <p>11 I --</p> <p>12 Q (BY MR. ZELLERS) And --</p> <p>13 A -- I -- I believe that my final systematic</p> <p>14 review was for me important to -- to confirm that</p> <p>15 association. And that wasn't done -- that wasn't</p> <p>16 completed until my report was basically -- close to</p> <p>17 when my report had to be drafted.</p> <p>18 Q The systematic review that you did was in</p> <p>19 and around September and October of 2018; is that</p> <p>20 right?</p> <p>21 A I believe the final statistical analysis</p> <p>22 was then, but my -- my systematic review went on for</p> <p>23 many months.</p> <p>24 Q Well, your systematic review, at least</p> <p>25 insofar as Dr. Hall assisted you, was in September</p>
<p style="text-align: right;">Page 99</p> <p>1 that the mean number of years is greater than 20.</p> <p>2 Q (BY MR. ZELLERS) If we look down at the</p> <p>3 group below, the number of cases, the mean number of</p> <p>4 years of talc use among users is greater than</p> <p>5 20 years, also for each of those groups; is that</p> <p>6 right?</p> <p>7 MS. O'DELL: Object to the form.</p> <p>8 A Dr. Wu found that the average number of</p> <p>9 years was greater than 20, yes.</p> <p>10 Q (BY MR. ZELLERS) All right. You have</p> <p>11 never published on, you know, any topic relating to</p> <p>12 talcum powder or any association between talcum</p> <p>13 powder and ovarian cancer; is that right?</p> <p>14 A I have not.</p> <p>15 Q Your opinion is that women exposed to</p> <p>16 perineal talcum powder products on a regular basis</p> <p>17 have about a 50 percent increase in their subsequent</p> <p>18 risk of developing serous invasive cancer; is that</p> <p>19 correct?</p> <p>20 A Yes, that is my opinion.</p> <p>21 Q You also opine in your report that there</p> <p>22 is a causal association between genital talcum</p> <p>23 powder use and ovarian cancer generally; is that</p> <p>24 right?</p> <p>25 MS. O'DELL: Object to the form.</p>	<p style="text-align: right;">Page 101</p> <p>1 of 2018; is that right?</p> <p>2 MS. O'DELL: Object to the form.</p> <p>3 A The systematic review that I described in</p> <p>4 my report has a lot of components. So one component</p> <p>5 is to do a complete comprehensive review of -- of</p> <p>6 what's been published.</p> <p>7 And that involved doing the search,</p> <p>8 according -- obtaining all the papers, and then</p> <p>9 reviewing the bibliography of all of those papers.</p> <p>10 Then reviewing all those papers critically</p> <p>11 and then abstracting data for those papers. Kind of</p> <p>12 towards the tail end of that review is to</p> <p>13 statistically combine the studies.</p> <p>14 Dr. Hall was involved both in abstracting</p> <p>15 the data as a second set of eyes and in doing the</p> <p>16 statistical summary. But I reached out to her after</p> <p>17 all of those initial points were completed. So that</p> <p>18 went on for many months.</p> <p>19 Q (BY MR. ZELLERS) Is it the objective of a</p> <p>20 systematic review to bring clarity to a research</p> <p>21 question by combining like-with-like data?</p> <p>22 MS. O'DELL: Object to the form.</p> <p>23 A The purpose of the systematic review is to</p> <p>24 take individual papers that may not have enough</p> <p>25 statistical power to provide by themselves,</p>

<p style="text-align: right;">Page 102</p> <p>1 individual results that are meaningful. And if the 2 methodology is combinable, to pool the sample size 3 to get greater statistical power to come up with a 4 conclusion. 5 But your question about combining like 6 with like is -- is -- is very important. 7 Q (BY MR. ZELLERS) In order for research to 8 be useful, it must be valid, correct? 9 A Yes. 10 Q Inaccurate and incomplete reporting of 11 methods can make research unreasonable and unusable; 12 is that right? 13 MS. O'DELL: Object to the form. 14 A I -- I -- I think there are separate 15 phases of research that need happen. I think the 16 reporting of methodology is so that other people can 17 duplicate your results, understand your results. 18 But in and of themselves, the reporting 19 does not influence the reliability of the -- of the 20 research. 21 Q (BY MR. ZELLERS) Is reporting of 22 methodology important? 23 A I -- I think reporting of methodology so 24 that other people can duplicate the results is 25 important.</p>	<p style="text-align: right;">Page 104</p> <p>1 been done, I tried, in writing my report, to 2 highlight the details of what would be needed to 3 understand my result. 4 But I have not, for example, included 5 certain details that you would typically put in a 6 journal article. 7 So in a journal article, you would always 8 publish the version of SAS or R that was used for 9 the report. I -- I would not have included that. 10 And -- and I believe some of the documents 11 I shared with you that Dr. Hall provided to me on 12 the methodology were included in the e-mail to me. 13 And I may not have included it in the 14 report, thinking that the reader would not -- you, 15 for example, would be interested in some of those 16 biostatistical nuances. 17 But when I publish it, I would put those 18 in because the readership might care about them. 19 Q You talked, I believe, a minute ago about 20 abstracting data; is that right? 21 A Yes. 22 Q Is data abstraction one of the most 23 important steps in conducting a meta-analysis or a 24 systematic review? 25 Would you agree with that?</p>
<p style="text-align: right;">Page 103</p> <p>1 So if -- if I move ahead as I'm planning 2 to publish my systematic review, then I would 3 include greater details about the methodology so 4 that other investigators could duplicate my work, 5 should -- should they so choose. 6 Q At least as of now, other scientists or 7 epidemiologists would not be able to reproduce what 8 you have done based upon your report -- 9 MS. O'DELL: Object -- 10 Q (BY MR. ZELLERS) -- correct? 11 MS. O'DELL: -- object to the form. 12 A I am -- I am not sure that that's the 13 case. 14 Q (BY MR. ZELLERS) Do you think that all of 15 the steps that you followed in terms of preparing 16 your systematic review are set forth in your report? 17 MS. O'DELL: Object to the form. 18 A I think the path that I followed in this 19 review and the method that I used is a method that I 20 have used in a number of other published systematic 21 reviews. 22 And so to the degree that people could 23 sort of say: Well, this is what Dr. Smith-Bindman 24 does in a review -- she focuses on stratified 25 results -- these are the methods that have done --</p>	<p style="text-align: right;">Page 105</p> <p>1 A I would agree with that. 2 Q Would you agree that the accuracy of the 3 data abstraction is very important to the validity 4 of the analysis? 5 A I think one of the hallmarks of doing a 6 systematic review is, in fact, to have several 7 people abstract the data points so that you can be 8 assured that there are -- that they're done as 9 accurately as possible, with the understanding of a 10 single data abstraction by a single person can never 11 be perfect. 12 And so the more people that abstract and 13 review, the greater the accuracy of the data. 14 Q Your data abstraction was not perfect, 15 correct? 16 A It was not. 17 MS. O'DELL: Object to the form. 18 Q (BY MR. ZELLERS) The data abstraction that 19 was done by Dr. Hall was not perfect; is that right? 20 MS. O'DELL: Object to the form. 21 A That is correct. 22 Q (BY MR. ZELLERS) If data is misrepresented 23 -- well, strike that. 24 Are you familiar with the 25 term "misrepresentation"?</p>

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1 MS. O'DELL: Object to the form.
2 A I -- I will admit I'm not sure what the
3 context is you're asking --
4 Q (BY MR. ZELLERS) Well --
5 A -- about.
6 Q -- let me try to put it in another context
7 or at least ask a question that may get to what I am
8 trying to get to.
9 If data is misrepresented from the
10 original study, the analysis -- the systematic
11 review or the meta-analysis can be comprised,
12 correct?
13 A Yes, I agree.
14 Q Inaccuracy and misrepresentation of data
15 are considered violations of generally accepted
16 standards of research; is that right?
17 MS. O'DELL: Object to the form.
18 A Misrepresentation of data suggests to me
19 that there's some malicious or devious attempt where
20 occasionally there are sometimes simple errors in
21 abstraction when you write down the No. 5 and, in
22 fact, the number really is .5.
23 And often when abstracting data, it's not
24 so much an error of writing down 5 or .5, but it's
25 choosing which number in that manuscript reflects

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1 what you are really trying to capture and get at.
2 So typically there are more than one way
3 to abstract data. It's why it's not -- it -- it's
4 why it's not simply having multiple people so they
5 don't make typos or small extraction mistakes, but
6 rather, that they're making similar choices.
7 And so misrepresentation, the way you have
8 asked it, makes it sound like there's some malicious
9 attempt to get it wrong or to -- to manipulate it
10 rather than the wrong number was chosen for either a
11 simple error or because there was a choice and the
12 choice was not made in a way that two people would
13 agree. And so...
14 Q (BY MR. ZELLERS) There can be differences
15 in the way different folks go about doing a research
16 project or a meta-analysis or a systematic review;
17 is that right?
18 A Yes.
19 Q In order for someone to reproduce or
20 replicate what another epidemiologist or scientist
21 has done, they need to see the steps that the
22 scientist or epidemiologist followed; is that right?
23 A That is --
24 MS. O'DELL: Object to the --
25 A -- correct.

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1 MS. O'DELL: -- form.
2 Q (BY MR. ZELLERS) Go back to my question.
3 And -- and with the background that you have given
4 and with your qualification, do you agree that
5 inaccuracy and misrepresentation are considered
6 violations of generally accepted standards of
7 research?
8 MS. O'DELL: Object to the form. If you
9 don't understand the question, you may ask him to
10 rephrase it. If --
11 A I --
12 MS. O'DELL: -- you understand --
13 A -- I --
14 MS. O'DELL: -- the question, feel free to
15 answer it.
16 A -- I felt like I had answered the question
17 that I understood, so it -- perhaps I'm not
18 understanding your question.
19 Q (BY MR. ZELLERS) Are you able to answer
20 that question?
21 A Yes. I think that misrepresentation of
22 data is not how I would describe an error in
23 abstraction of data or in a difference of opinion
24 about what value reflects the data point you were
25 looking for. I wouldn't consider that a

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1 misrepresentation of data.
2 Q Understood. Let me ask my question once
3 more.
4 A Okay.
5 Q Misrepresentation of data would be a
6 violation of generally accepted standards of
7 research, correct?
8 A I agree that misrepresentation of data
9 would be a violation of research.
10 Q A causal analysis cannot be determined
11 based on a single piece of evidence, but requires
12 consideration of the totality of relevant evidence.
13 Do you agree with that?
14 A I would say in the field of epidemiology,
15 it's unusual to have a single piece of evidence.
16 But I think in some circumstances a single piece of
17 evidence can establish causality. Not typically in
18 epidemiology work.
19 Q What do you mean in your report by "causal
20 association"?
21 A So in my report, I did research as -- sort
22 of as I outlined in my Table of Contents of, you
23 know, number of different areas.
24 Q Okay. And I'm going to ask you about
25 those. Right now my question just --

<p style="text-align: right;">Page 110</p> <p>1 A No.</p> <p>2 Q -- is --</p> <p>3 A I understand. I --</p> <p>4 Q What --</p> <p>5 A -- understand.</p> <p>6 Q -- do you mean when you say "causal</p> <p>7 association"?</p> <p>8 A No. I -- I understand. I -- I apologize.</p> <p>9 I was not getting there quite quickly enough.</p> <p>10 Q That's all right.</p> <p>11 A So I did research on several topics that I</p> <p>12 thought were highly relevant to coming up with a</p> <p>13 causal determination, and I put those different</p> <p>14 pieces of research and expertise together in terms</p> <p>15 of the causality by specifically looking at the</p> <p>16 Bradford Hill criteria.</p> <p>17 Q I -- and I'm going to get to eventually, I</p> <p>18 hope, why you came up with whatever opinion you came</p> <p>19 up with.</p> <p>20 Right now I'm just trying to understand</p> <p>21 what you mean when you use the words "causal</p> <p>22 association."</p> <p>23 MS. O'DELL: Object to the form. Is there</p> <p>24 a specific case in her report that --</p> <p>25 Q (BY MR. ZELLERS) Sure. "Conclusion."</p>	<p style="text-align: right;">Page 112</p> <p>1 Q Is that what you mean by "causal</p> <p>2 association"?</p> <p>3 A Yes, it is.</p> <p>4 Q What are the other causes of ovarian</p> <p>5 cancer?</p> <p>6 A So there's a whole long list of risk</p> <p>7 factors for ovarian cancer.</p> <p>8 Q What is the difference between a risk</p> <p>9 factor and a cause?</p> <p>10 A A risk factor is something that puts you</p> <p>11 at increased risk, increases the probability that</p> <p>12 you will get ovarian cancer. And there are</p> <p>13 innumerable mechanisms and ways that that can go</p> <p>14 about.</p> <p>15 But often -- not entirely, but often, you</p> <p>16 don't think of risk factors as being things that you</p> <p>17 can alter. That's not entirely true.</p> <p>18 There are some risk factors. For example,</p> <p>19 the use of -- well, the -- the most commonly cited</p> <p>20 risk factor for cancer in general is smoking, and</p> <p>21 that's clearly something that can be started or</p> <p>22 ended, that can be changed.</p> <p>23 But often you think of risk factors as</p> <p>24 things that can't be changed. So elevation in age,</p> <p>25 inherited genetics.</p>
<p style="text-align: right;">Page 111</p> <p>1 Page 41 of the report, In conclusion, substantial</p> <p>2 evidence supports a strong, positive, and causal</p> <p>3 association between ovarian cancer and genital</p> <p>4 exposure to talcum powder products.</p> <p>5 I just want to know what you mean when you</p> <p>6 say "causal association."</p> <p>7 MS. O'DELL: I think she answered your</p> <p>8 question.</p> <p>9 But you may answer him, if you understand</p> <p>10 it.</p> <p>11 A I -- I think that the -- the four</p> <p>12 sentences just above that says that, Summary</p> <p>13 consideration of causality of talc powder products</p> <p>14 and ovarian cancer using the Bradford Hill.</p> <p>15 So I -- I -- I believe, using this</p> <p>16 framework, the Bradford Hill, the components of the</p> <p>17 Bradford Hill demonstrate that ovarian cancer is</p> <p>18 caused by regular talcum powder exposure based on</p> <p>19 the strength of the association, based on the</p> <p>20 consistency, the temporality of -- of the components</p> <p>21 of my analysis.</p> <p>22 Q (BY MR. ZELLERS) Do you believe that</p> <p>23 perineal use of talcum powder by women on a regular</p> <p>24 basis causes ovarian cancer?</p> <p>25 A Yes, I do.</p>	<p style="text-align: right;">Page 113</p> <p>1 So those things lead to ovarian cancer,</p> <p>2 the risk factors that I describe in my report. But</p> <p>3 most of them are not things that you can influence.</p> <p>4 Some of them are, but most of them are not.</p> <p>5 Where talcum powder products -- the use of</p> <p>6 perineal talcum powder products -- products is</p> <p>7 something that can be changed. That -- that is a</p> <p>8 behavior, and so I think that's the distinction that</p> <p>9 I would make.</p> <p>10 Q A risk factor is something that increases</p> <p>11 the potential risk of a disease, but cannot be</p> <p>12 changed, correct?</p> <p>13 MS. O'DELL: Object to the form.</p> <p>14 A I -- I said that it's often something that</p> <p>15 can't be changed. But -- but again, there are risk</p> <p>16 factors that, by convention, we consider risk</p> <p>17 factors, but that are modifiable.</p> <p>18 Q (BY MR. ZELLERS) All right.</p> <p>19 A And I gave smoking as an example.</p> <p>20 Q A cause of a disease is something that can</p> <p>21 be modified; is -- is that correct?</p> <p>22 A It --</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A -- again, it is often used that way.</p> <p>25 Q (BY MR. ZELLERS) What makes a factor cross</p>

<p style="text-align: right;">Page 114</p> <p>1 the line from being a risk factor to being a cause?</p> <p>2 A I -- I think what I was suggesting is it's</p> <p>3 a blurry distinction. I think it's by convention</p> <p>4 things that cannot be modified are typically thought</p> <p>5 as risk factors. Things that can be modified are</p> <p>6 generally thought about as being in the causal</p> <p>7 family -- pathway.</p> <p>8 But there's no distinction that you can</p> <p>9 separate something that increases your risk of</p> <p>10 something versus something that causes it. The --</p> <p>11 the causal pathways could be the exact same causal</p> <p>12 pathways in both situations.</p> <p>13 Q What other causes are there of ovarian</p> <p>14 cancer?</p> <p>15 A So I'm guessing from what I have just said</p> <p>16 that you are asking about causes and risk factors or</p> <p>17 would you like them to be --</p> <p>18 Q Well, do you use "risk factor" and "cause"</p> <p>19 interchangeably or are they different?</p> <p>20 MS. O'DELL: Object to the form; asked and</p> <p>21 answered.</p> <p>22 A I -- I believe that by convention we</p> <p>23 typically describe risk factors that are things that</p> <p>24 cannot be altered.</p> <p>25 But technically there is no difference</p>	<p style="text-align: right;">Page 116</p> <p>1 Smoking is a possible risk factor.</p> <p>2 So all of those are in the category of</p> <p>3 risk factors for ovarian cancer.</p> <p>4 Q My question goes to cause. Based upon</p> <p>5 your review of the literature over the past year,</p> <p>6 what other causes of ovarian cancer have you</p> <p>7 identified, if any?</p> <p>8 MS. O'DELL: Objection to form; asked and</p> <p>9 answered.</p> <p>10 A There are other contributors to ovarian</p> <p>11 cancer like pelvic inflammatory disease, which I</p> <p>12 think was on the list of what I just noted.</p> <p>13 There are no other modifiable factors that</p> <p>14 I would put on the list of things that cause ovarian</p> <p>15 cancer other than exposure to talc powder products.</p> <p>16 Q (BY MR. ZELLERS) Based upon your review of</p> <p>17 the literature in terms of a cause for ovarian</p> <p>18 cancer, the only cause that you have identified is</p> <p>19 the regular perineal use of talcum powder by women,</p> <p>20 correct?</p> <p>21 MS. O'DELL: Object to the form.</p> <p>22 Misstates her testimony.</p> <p>23 A I believe I just said that pelvic</p> <p>24 inflammatory disease increases the risk of ovarian</p> <p>25 cancer.</p>
<p style="text-align: right;">Page 115</p> <p>1 between factors, covariants that influence your</p> <p>2 cancer risk that you can change or not. So I can</p> <p>3 tell you the list of things that fall into those two</p> <p>4 categories.</p> <p>5 Q (BY MR. ZELLERS) All right. What I want</p> <p>6 to know is: Based upon your review and your</p> <p>7 research over the past year or so, other than</p> <p>8 perineal use of talcum powder on a regular basis,</p> <p>9 what other causes of ovarian cancer are there?</p> <p>10 A So in my report on page 11, I write that,</p> <p>11 Numerous risk factors are identified for ovarian</p> <p>12 cancer. Unfortunately, few can be modified by</p> <p>13 therapies or lifestyle changes. Risk factors</p> <p>14 include personal or family history of -- of cancer,</p> <p>15 inherited mutations, BRC1 and BRC2, advanced age,</p> <p>16 white, race, education, endometriosis.</p> <p>17 Other factors that may increase --</p> <p>18 increase ovarian cancer due to estrogen exposure</p> <p>19 include having no pregnancies or advanced age at</p> <p>20 first birth, obesity, post menopausal hormone</p> <p>21 therapy.</p> <p>22 Several factors I list are associated with</p> <p>23 a decreased risk of ovarian cancer such as breast</p> <p>24 feeding or multiple pregnancies, oral</p> <p>25 contraceptions, tubal ligation, or hysterectomy.</p>	<p style="text-align: right;">Page 117</p> <p>1 Q (BY MR. ZELLERS) Is pelvic in --</p> <p>2 MS. O'DELL: Excuse me. I'm sorry. Were</p> <p>3 you finished, Dr. Smith-Bindman? I mean, if you're</p> <p>4 not, you -- you may continue. If so, I apologize --</p> <p>5 A I --</p> <p>6 MS. O'DELL: -- for interrupting you both.</p> <p>7 A -- I was going to add that endometriosis</p> <p>8 has been noted also as a contributor to --</p> <p>9 Q (BY MR. ZELLERS) Is -- are you finished?</p> <p>10 A -- I am.</p> <p>11 Q Okay. Is pelvic inflammatory disease a</p> <p>12 cause of ovarian cancer?</p> <p>13 A I -- I -- you -- you keep asking me the</p> <p>14 same question, and I don't understand the</p> <p>15 distinction that you are asking me to make between</p> <p>16 something that causes cancer and something that's a</p> <p>17 risk factor.</p> <p>18 In both situation -- situations there is a</p> <p>19 probability of getting a disease versus not getting</p> <p>20 a disease. There's no 100 percent association, and</p> <p>21 so most people, as an analogy who smoke cigarettes,</p> <p>22 do not get lung cancer. It's fewer than 15 percent.</p> <p>23 Does smoking cause lung cancer? Yes. Is</p> <p>24 it a risk factor for lung cancer? Yes. Is it a</p> <p>25 single pathway that everyone who smokes, gets lung</p>

<p style="text-align: right;">Page 118</p> <p>1 cancer? No.</p> <p>2 So I -- you're asking me to make a</p> <p>3 distinction that I don't make in my head, so I'm --</p> <p>4 I'm not sure -- all of the things I suggested as</p> <p>5 risk factors in some women will cause them to have</p> <p>6 cancer.</p> <p>7 Q You are opining in this case that the</p> <p>8 regular perineal use of talcum powder causes ovarian</p> <p>9 cancer, correct?</p> <p>10 A Yes, I am.</p> <p>11 Q My question is: Does pelvic inflammatory</p> <p>12 disease cause ovarian cancer?</p> <p>13 A In some women, pelvic inflammatory disease</p> <p>14 will cause cancer.</p> <p>15 Q You -- you would list a pelvic</p> <p>16 inflammatory disease as a cause of ovarian cancer;</p> <p>17 is that your testimony?</p> <p>18 MS. O'DELL: Objection, asked and</p> <p>19 answered.</p> <p>20 A I would include pelvic inflammatory</p> <p>21 disease with all the other ovarian cancer risk</p> <p>22 factors like BRCA1 and 2 as being one of a large</p> <p>23 number of contributors and risk factors for ovarian</p> <p>24 cancer.</p> <p>25 There -- there is not -- no other</p>	<p style="text-align: right;">Page 120</p> <p>1 Q (BY MR. ZELLERS) Have you done anything to</p> <p>2 advise the health community about your belief that</p> <p>3 there is a causal association between talcum powder</p> <p>4 use and ovarian cancer?</p> <p>5 A I have mentioned to you that I have spoken</p> <p>6 about my review to several individuals, several</p> <p>7 close mentors of mine in leadership roles within the</p> <p>8 healthcare community. So I --</p> <p>9 Q Who?</p> <p>10 A -- not -- not individuals I am willing to</p> <p>11 name.</p> <p>12 Q You won't tell me who you have talked to</p> <p>13 about your belief or your theory that there's a</p> <p>14 causal association between genital talcum powder use</p> <p>15 and ovarian cancer?</p> <p>16 A I would prefer not to share that</p> <p>17 information.</p> <p>18 Q Have you contacted any public health</p> <p>19 authorities such as the FDA or the National Cancer</p> <p>20 Institute?</p> <p>21 A I have not.</p> <p>22 Q Have you written any type of an op-ed or</p> <p>23 other news article on this topic?</p> <p>24 A Not yet. I have not.</p> <p>25 Q You have done that in the past; is that</p>
<p style="text-align: right;">Page 119</p> <p>1 exposure -- a modifiable exposure that I can think</p> <p>2 of that leads to getting ovarian cancer or causing</p> <p>3 ovarian cancer.</p> <p>4 Q (BY MR. ZELLERS) In -- in your practice as</p> <p>5 a radiologist, you do not evaluate what caused an</p> <p>6 individual patient's ovarian cancer; is that right?</p> <p>7 MS. O'DELL: Object to the form.</p> <p>8 A As a -- a radiologist, I do not.</p> <p>9 Q (BY MR. ZELLERS) You don't diagnose what</p> <p>10 caused any individual patient's ovarian cancer; is</p> <p>11 that right, in your practice -- your medical</p> <p>12 practice.</p> <p>13 MS. O'DELL: Objection, asked and</p> <p>14 answered.</p> <p>15 A I -- I -- I do not. I diagnose ovarian</p> <p>16 cancer. I diagnosis pelvic inflammatory disease.</p> <p>17 But in an individual patient, I wouldn't tell a</p> <p>18 patient why they got ovarian cancer.</p> <p>19 Q (BY MR. ZELLERS) You -- you have not, at</p> <p>20 least as of this time, published on your theory that</p> <p>21 there is a causal association between genital talcum</p> <p>22 powder exposure and ovarian cancer; is that right?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A I have not published on my conclusion that</p> <p>25 talcum powder products causes ovarian cancer.</p>	<p style="text-align: right;">Page 121</p> <p>1 right?</p> <p>2 A Had -- you're asking if I have written</p> <p>3 op-eds on areas I have done research?</p> <p>4 Q Yes.</p> <p>5 A Yes, I have.</p> <p>6 Q Back in 2014, you did an op-ed in The New</p> <p>7 York Times relating to CT scans; is that right?</p> <p>8 A Yes, I did.</p> <p>9 Q All right. You concluded or at least put</p> <p>10 in the op-ed, In 2007, CT scans will cause 29,000</p> <p>11 excess cancer cases and 14,500 excess deaths; is</p> <p>12 that right?</p> <p>13 A I don't have it in front of me. But it</p> <p>14 looks like you do, and so I'm going to guess that</p> <p>15 that's correct.</p> <p>16 Q Well, does that sound right to you?</p> <p>17 A It does sound right.</p> <p>18 Q You put in that editorial or op-ed that in</p> <p>19 your opinion, 3 percent to 5 percent of all future</p> <p>20 cancers may result from exposure to medical imaging</p> <p>21 such as CT scans; is that right?</p> <p>22 MS. O'DELL: And if you have a</p> <p>23 recollection and -- and you -- and your memory</p> <p>24 confirms those -- those facts, please feel free to</p> <p>25 testify to it. If you need to see the op-ed, then</p>

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1 I'm sure counsel would be willing to put it in front
 2 of you.
 3 A That particular statistic, I don't have to
 4 see. I know that static --
 5 Q (BY MR. ZELLERS) All right.
 6 A -- so yes.
 7 Q You are familiar with the Center for
 8 Disease Control, correct?
 9 A Yes, I am.
 10 Q The CDC or Center for Disease Control is a
 11 reputable organization; is that right?
 12 MS. O'DELL: Object to the form.
 13 A I think they're a very reputable
 14 organization.
 15 Q (BY MR. ZELLERS) You have served on
 16 several committees for the CDC in the past; is that
 17 right?
 18 A I currently work on several committees
 19 with them.
 20 Q Do the doctors and scientists in the CDC
 21 work hard to protect women's health, based on your
 22 experience?
 23 A Yes, they do.
 24 Q In forming your opinions in this case, did
 25 you consider the risk factors that the CDC

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1 recognizes for ovarian cancer?
 2 A From my report, I read an enormous number
 3 of articles, and I spent considerably time
 4 considering those articles from a data point of
 5 view.
 6 And I did not, for the most part, weigh
 7 other organization's summaries if they were not
 8 quantitative and very explicit in what reviews they
 9 did, what literature they included.
 10 And sometimes they -- organizations did do
 11 that, but did not do nearly as -- a comprehensive
 12 job. So I -- I would not have relied on any
 13 professional organization's reviews unless they were
 14 quantitative the way -- the way my own were?
 15 MR. ZELLERS: Move to strike as
 16 nonresponsive.
 17 Q (BY MR. ZELLERS) Let me ask the question
 18 again. In forming your opinions in this case, did
 19 you consider the risk factors that the CDC
 20 recognizing for ovarian cancer?
 21 MS. O'DELL: Object to the form.
 22 A I saw documents on their websites that
 23 list risk factors, and no individual organization's
 24 summaries, either for patients or for clinicians,
 25 formed a very large piece of my opinion. It was one

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1 of many pieces of information I used.
 2 Q (BY MR. ZELLERS) Are you aware that in
 3 their patient-facing websites, as well as their
 4 publicly available information about ovarian cancer,
 5 the CDC does not identify perineal use of talcum
 6 powder as a risk factor for ovarian cancer?
 7 A Yes, I do remember seeing that.
 8 Q You don't have any reason to believe that
 9 the folks at the CDC have not kept up to date with
 10 talc and ovarian cancer epidemiology, do you?
 11 MS. O'DELL: Object to the form.
 12 A I believe that the comprehensiveness of
 13 the review that I did and the amount of time that I
 14 put into this review, as I have in -- in many other
 15 reviews, requires a very deep dive into the
 16 literature.
 17 And I do not believe that the CDC has
 18 funding or resources to do that kind of deep dive.
 19 And so typically what they do is sort of review some
 20 things that have been published. Most things, they
 21 don't end up reviewing.
 22 And so I have no reason to believe anyone
 23 at the CDC deliberately didn't do a comprehensive
 24 review of the literature, but -- nor do I have any
 25 evidence that they did a comprehensive review of the

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1 literature.
 2 Q (BY MR. ZELLERS) Do you have any personal
 3 knowledge one way or the other as to the extent of
 4 the review of the science and literature that the
 5 CDC did in compiling its list of risk factors for
 6 ovarian cancer?
 7 A I --
 8 MS. O'DELL: Object to the form.
 9 A -- I would have to refresh my memory by
 10 looking at their -- their website and documents. If
 11 you provided those, I could.
 12 Q (BY MR. ZELLERS) My question is: Do you
 13 have any personal knowledge one way or the other as
 14 to what the CDC has done with respect to a review of
 15 the scientific literature in compiling its list of
 16 risk factors for ovarian cancer?
 17 A I don't know offhand what they did. And I
 18 don't recall when looking at their website, what
 19 references they listed.
 20 I think if their reference list included a
 21 very short -- small number of references, I would
 22 have concluded that they had not done a very
 23 comprehensive review.
 24 Q (BY MR. ZELLERS) My question is: Do you
 25 have any personal knowledge as to what the CDC did

<p style="text-align: right;">Page 126</p> <p>1 or did not do with respect to its review of the 2 literature?</p> <p>3 A Again, I don't know off the top of my 4 head. But I know I went to their website, and I 5 don't --</p> <p>6 Q Other than looking at their website, do 7 you have any personal knowledge?</p> <p>8 A No, I do not.</p> <p>9 Q All right. Have you communicated to 10 anyone at the CDC that you disagree with their 11 position?</p> <p>12 A I -- I'm laughing at the nature of the 13 question. There wouldn't be anyone at the CDC to 14 disagree with.</p> <p>15 Q There -- there's no one at the CDC that 16 you, as a concerned radiologist, could go to and 17 say: Hey, I think that you should list perineal 18 talc use as a risk factor for ovarian cancer?</p> <p>19 MS. O'DELL: Object to the form.</p> <p>20 Q (BY MR. ZELLERS) There's no one you could 21 talk to at the CDC about that?</p> <p>22 A I -- I would -- I would have to confirm 23 that that -- I have been -- I -- I study 24 environmental carcinogens.</p> <p>25 And you pointed out my New York Times</p>	<p style="text-align: right;">Page 128</p> <p>1 MS. O'DELL: Object to the form.</p> <p>2 A Naive to suggest that a single person 3 could just call them and say: I have looked at this 4 topic, and you should change what you are doing.</p> <p>5 Q (BY MR. ZELLERS) Are you familiar with the 6 National Institute of Health?</p> <p>7 A I am.</p> <p>8 Q You have received funding from the 9 National Institute of Health; is that right?</p> <p>10 A I have.</p> <p>11 Q Do you know that the National Institute of 12 Health does not list talc use as a risk factor for 13 ovarian cancer?</p> <p>14 MS. O'DELL: Object to form.</p> <p>15 A Again, I -- yeah, I know that the NCI, PDQ 16 that writes reports for patients and clinicians 17 about risk factors for cancer has a report on risk 18 factors for ovarian cancer and that they conclude 19 that there's inadequate evidence for talc.</p> <p>20 Q (BY MR. ZELLERS) Inadequate evidence, 21 correct?</p> <p>22 A I -- I -- I wasn't finished.</p> <p>23 Q Please finish.</p> <p>24 A So they don't stand -- just to clarify, 25 for the National Institute of Health. It's a very</p>
<p style="text-align: right;">Page 127</p> <p>1 op-ed that put a message out there that said: I 2 think this is an environmental carcinogen.</p> <p>3 And I have spoken about that topic in many 4 forms. I have testified before Congress several 5 times. I testified to the FDA. I have spoken to 6 CMS.</p> <p>7 All of that took years to get people to 8 hear those messages. It was not that: Oh, I see 9 there's a problem here. Let me just tell the top 10 person to do that.</p> <p>11 And -- and so I'm -- you're suggesting 12 there's someone at the CDC that I could call and 13 say: Oh, by the way, I think that's an important 14 topic. I appreciate your giving me that idea. I 15 will move forward once I publish a paper on this 16 topic.</p> <p>17 But -- but that's not nearly as -- as 18 simple as you're suggesting in your question. 19 There's a naiveness there that there's someone at 20 the CDC who would -- who takes responsibility for 21 what they do and -- on all of their websites and you 22 can sort of give them feedback on that.</p> <p>23 Q You believe I'm being naive to think that 24 there's a person responsible at the CDC for 25 compiling a list of risk factors for ovarian cancer?</p>	<p style="text-align: right;">Page 129</p> <p>1 prestige body. It's an organization within a small 2 part of the NCI.</p> <p>3 I know it well, because I served on that 4 committee for many years. I know the process 5 whereby they review the literature and created a 6 whole a bunch of standards within what they do 7 around that.</p> <p>8 And I looked and saw that they updated 9 their summary of talc in 2018. And -- and yet, 10 within that summary, they do list the references 11 that they cite, and they omit a large number of 12 references that are recent.</p> <p>13 So I do know their conclusion. I do not 14 agree with their conclusion. And there were large 15 gaps in their literature. And that update was very 16 recent.</p> <p>17 I -- I told you I don't know the 18 leadership at the CDC, and they don't have a 19 process. But I do know the leadership on this 20 committee and -- and will point out their omissions 21 to this committee.</p> <p>22 Q Well, I haven't gotten to the National 23 Cancer Institute yet.</p> <p>24 My question was: Do you know that NIH, 25 the National Institute of Health, does not list use</p>

<p style="text-align: right;">Page 130</p> <p>1 of talcum powder as a risk factor for ovarian 2 cancer? 3 A So I -- I -- I don't know what -- I'm 4 sorry. I don't know what you're talking about, 5 the -- 6 Q All right. 7 A -- NIH. 8 Q Take a look, if you will, at Deposition 9 Exhibit 19, which is captioned NIH steer -- or 10 "SEER, S E E R, Training Modules" and has got "Risk 11 Factors" at the top. 12 (Exhibit 19 was marked for identification 13 and is attached to the transcript.) 14 MS. O'DELL: Thank you. 15 A So SEER is also a part of National Cancer 16 Institute. It's the surveillance epidemiology -- 17 MR. LAPINSKI: Have her wait for a 18 question. 19 MS. O'DELL: Sorry. Just wait for his 20 question. Yeah, thanks, Dan. 21 Q (BY MR. ZELLERS) You recognize Exhibit 19 22 as a training module from NIH and specifically from 23 the National Cancer Institute; is that right? 24 A So this says at the top "SEER Training 25 Modules."</p>	<p style="text-align: right;">Page 132</p> <p>1 include modifiable and nonmodifiable parameters. 2 Is that right? And then it lists out 3 nonmodifiable parameters and modifiable parameters; 4 is that right? 5 A Yes, that's what this -- 6 Q Talcum -- 7 A -- says. 8 Q -- powder use is not listed, correct? 9 A Correct. 10 Q All right. Take a look, if you will -- 11 and this is the document that you were talking about 12 a moment ago -- at Deposition Exhibit 20. 13 (Exhibit 20 was marked for identification 14 and is attached to the transcript.) 15 Q (BY MR. ZELLERS) This is the "National 16 Cancer Institute Review of Ovarian, Fallopian Tube, 17 and Primary Peritoneal Cancer Prevention PDQ"; is 18 that right? 19 A Yes, it is. 20 Q This is the document that you told us a 21 few minutes ago that you disagree with the 22 conclusion; is that right? 23 And specifically if you go to page 5 of 9 24 under "Perineal Talc Exposure," the statement from 25 the National Cancer Institute in this document is</p>
<p style="text-align: right;">Page 131</p> <p>1 I don't know what this is. I know SEER 2 quite well. It's the National Cancer Registries. 3 But I -- I don't -- don't know what this training 4 module is. But I do see that you are showing me 5 some risk factors. 6 Q Talc is not listed as a risk factor for 7 ovarian cancer in this document, Exhibit 19, that 8 was updated in June of 2018 from NIH and the 9 National Cancer Institute; is that right? 10 A I -- I want to sort of explain my 11 confusion. The SEER, Surveillance, Epidemiology, 12 and End Result, program does not train or educate 13 individuals typically using documents like this. 14 Often this is for cancer abstractors to 15 know what information they're asking their 16 abstractors to collect. 17 I -- I don't know what this is, but it 18 doesn't look to me like something that's identifying 19 risk factors as much as asking medical chart 20 abstractors to write down information that they're 21 collecting as part of their data. 22 Q My question is very simple. This is a 23 list that at the top says "Risk Factors." 24 The introductory statement says, The main 25 risk and protective factors for ovarian cancers</p>	<p style="text-align: right;">Page 133</p> <p>1 that the weight of evidence does not support an 2 association between perineal talc exposure and an 3 increased risk of ovarian cancer. Results from 4 case-control and cohort studies are inconsistent. 5 Is that right? 6 A That is what they conclude. 7 Q This was updated, if you looked at the 8 last page, page 9 of 9, on January 4 of 2019; is 9 that right? 10 MS. O'DELL: Object to the form. 11 A Can you show me where it's been updated? 12 Q (BY MR. ZELLERS) Sure. Look at the very 13 last page. In bold, "Updated January 4, 2019"; is 14 that right? 15 A It does say that -- 16 Q All right. 17 A -- yes. 18 Q Are there limitations on epidemiological 19 data? 20 A Yes, there are. 21 Q Do you agree that epi -- epidemiologic 22 data alone cannot permit a determination regarding 23 causation? 24 A I'm sorry. Can you just -- 25 Q Do you need me to say it again or can you</p>

<p style="text-align: right;">Page 134</p> <p>1 read it off the screen?</p> <p>2 A I can read it off the screen. I think</p> <p>3 epidemiologic data can provide an enormous amount of</p> <p>4 information about causation. But there are other</p> <p>5 considerations that would have to be also taken into</p> <p>6 account to also support that.</p> <p>7 Q Can epidemiologic data alone permit a</p> <p>8 determination regarding causation?</p> <p>9 MS. O'DELL: Object to the form.</p> <p>10 A I think epidemiologic data can be used in</p> <p>11 combination with other data to determine causality,</p> <p>12 but by itself cannot be used alone to determine</p> <p>13 causality.</p> <p>14 Q (BY MR. ZELLERS) The current epidemiologic</p> <p>15 data, as it exists, does not enable someone to</p> <p>16 distinguish between brands of cosmetic talc</p> <p>17 products; is that right?</p> <p>18 MS. O'DELL: Object to the form.</p> <p>19 A I would agree.</p> <p>20 Q (BY MR. ZELLERS) You can't tell in any of</p> <p>21 the 40 plus studies that you reviewed, that the</p> <p>22 women who were involved in those studies used talc</p> <p>23 products manufactured by Johnson & Johnson</p> <p>24 Consumer, Inc., or by another company; is that</p> <p>25 right?</p>	<p style="text-align: right;">Page 136</p> <p>1 awful lot of Johnson & Johnson baby powder over the</p> <p>2 last 50 plus years. And -- and I am --</p> <p>3 Q (BY MR. ZELLERS) And --</p> <p>4 A -- not sure whether there's lots of other</p> <p>5 dominant players in the space. I -- I don't know</p> <p>6 that.</p> <p>7 My impression is that Johnson -- baby</p> <p>8 powder baby is a Johnson & Johnson a product very,</p> <p>9 very often.</p> <p>10 Q But you have not done any type of survey</p> <p>11 --</p> <p>12 A I have --</p> <p>13 Q -- or analysis?</p> <p>14 A -- I have not.</p> <p>15 Q If the biological mechanism by which a</p> <p>16 talcum powder product can increase the risk of</p> <p>17 ovarian cancer is because of a particular</p> <p>18 contaminant or collection of contaminants, but that</p> <p>19 contaminant or collection of contaminants does not</p> <p>20 exist in all talcum powder products, will the</p> <p>21 epidemiologic evidence that exists today allow you</p> <p>22 to see that distinction?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A You're asking about contaminants of talcum</p> <p>25 powder products. My understanding from what I have</p>
<p style="text-align: right;">Page 135</p> <p>1 MS. O'DELL: Object to the form.</p> <p>2 A I -- I would agree that most of the papers</p> <p>3 that I read did not specify what the source of the</p> <p>4 baby powder was.</p> <p>5 Q (BY MR. ZELLERS) Based on the analysis</p> <p>6 that you have done, you're not able to draw an</p> <p>7 opinion specifically about an increased risk of</p> <p>8 ovarian cancer that is tied to a particular brand of</p> <p>9 talcum powder, correct?</p> <p>10 MS. O'DELL: Object to the form.</p> <p>11 A My impression is that a large proportion</p> <p>12 of the talcum powder products that are available</p> <p>13 happen to be made by Johnson & Johnson, but I do not</p> <p>14 know for any given study -- for most of the studies,</p> <p>15 at least, what kind of talcum powder it was.</p> <p>16 Q (BY MR. ZELLERS) Okay. Is your impression</p> <p>17 that you just shared with us, you know, based on</p> <p>18 information you have received from plaintiffs'</p> <p>19 counsel?</p> <p>20 MS. O'DELL: Object to the form. Don't --</p> <p>21 don't discuss what's been provided by -- let me say</p> <p>22 that again.</p> <p>23 Don't -- don't discuss conversations with</p> <p>24 plaintiffs' counsel. Thank you.</p> <p>25 A I -- my impression is based on seeing an</p>	<p style="text-align: right;">Page 137</p> <p>1 reviewed is that the components of talcum powder</p> <p>2 products include asbestos, include fibrous talc,</p> <p>3 include heavy metals, include fragrances.</p> <p>4 Let's get rid of the header -- the --</p> <p>5 the fragrances. Just the heavy metals, the</p> <p>6 asbestos, and the fibrous talc. My understanding is</p> <p>7 that those are in the same mines as the platy talc,</p> <p>8 which is the desired part of talc.</p> <p>9 To the degree that those are all part and</p> <p>10 parcel of the same product, they're not -- I</p> <p>11 wouldn't think of them as contaminants. I would</p> <p>12 think of them as just part of the product.</p> <p>13 And so to the degree that that product</p> <p>14 cannot be separated, I would be concerned that any</p> <p>15 talcum powder products have all of the above.</p> <p>16 I separated fragrance, because that's</p> <p>17 something that's added. That's not mined directly.</p> <p>18 But the other items, my understanding is that's part</p> <p>19 of the talc.</p> <p>20 Q You don't know one way or the other</p> <p>21 whether talcum powder products contain asbestos, do</p> <p>22 you?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A You're asking me to opine whether talcum</p> <p>25 powder products contain asbestos?</p>

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1 Q (BY MR. ZELLERS) Yes.
 2 A Yes, I -- I feel very certain that talcum
 3 powder products, at least over many years, contained
 4 asbestos.
 5 Q Is that part of your opinion in this case?
 6 A Yes, it is.
 7 Q Is it your opinion in this case that
 8 talcum powder products contain trace amounts of
 9 heavy metals?
 10 A Yes, it is.
 11 Q Is it also part of your opinion in this
 12 case that talcum powder products contain different
 13 fragrance chemicals?
 14 A Yes, it is.
 15 Q Do you have any opinion as to how many
 16 fragrance chemicals are contained in talcum powder
 17 manufactured by a Johnson & Johnson company at any
 18 time?
 19 MS. O'DELL: Object to the form. With
 20 regard to "opinion."
 21 A I have seen long lists of chemicals and
 22 fragrances that are contained.
 23 I'm not familiar enough with -- with the
 24 testing that was done to understand how that's
 25 changed over time in a Johnson & Johnson product

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1 versus other talcum powder products.
 2 Q (BY MR. ZELLERS) Do you have any opinion
 3 or knowledge as to the amount or concentration of
 4 particular fragrance chemicals that are contained in
 5 talcum powder manufactured by Johnson & Johnson?
 6 A I -- I do not.
 7 Q Do you have any opinion or knowledge as to
 8 the amount or concentration of trace chemicals
 9 -- strike that -- trace heavy metals that may be
 10 contained in talcum powder manufactured by Johnson &
 11 Johnson?
 12 A I have seen reports of the amounts that --
 13 you know, sort of in the ballpark of hundreds to
 14 thousands of parts per million.
 15 But I'm not an expert in understanding
 16 those numbers in comparison to the concentrations in
 17 other things that we're exposed to. They're much
 18 higher. They're orders of magnitudes higher, but
 19 I'm not an expert to understand how those different
 20 concentrations might be expected to have an
 21 influence on talc.
 22 Q The same question with respect to
 23 asbestos. Do you have any opinion or knowledge as
 24 to the amount or concentration of asbestos that you
 25 believe is contained in any talcum powder

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1 manufactured by Johnson & Johnson?
 2 MS. O'DELL: Object to the form. to the
 3 form.
 4 A So unlike the question about heavy metals
 5 where it sort -- there are traces of heavy metals in
 6 other things to which we're exposed regularly, like
 7 water. We don't expect any concentrations of
 8 asbestos in products that we're exposed to.
 9 And so put in that context, while I'm not
 10 an expert in the mineralogy, the numbers that I have
 11 seen are tens of thousands to millions of fibers
 12 that might be in grams of product seem like an awful
 13 lot of units or dose of -- of asbestos or fibrous
 14 talc.
 15 MR. ZELLERS: Move to strike as
 16 nonresponsive.
 17 Q (BY MR. ZELLERS) You do not have personal
 18 knowledge as to any amounts or concentrations of
 19 asbestos in talcum powder manufactured by Johnson &
 20 Johnson --
 21 MS. O'DELL: Objection.
 22 Q (BY MR. ZELLERS) -- correct?
 23 MS. O'DELL: Objection, asked and
 24 answered.
 25 A I have seen several reports of Johnson &

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1 Johnson products that have been tested for
 2 concentrations of asbestos or asbestiform talc that
 3 have concentrations shown kind of in ranges of a
 4 tenth of a percent or, as I mentioned, tens of
 5 thousands or mid -- millions of fibers.
 6 And those have been tested by -- by
 7 several different people, but coming up with units
 8 of dose within Johnson & Johnson talcum powder
 9 products.
 10 Q (BY MR. ZELLERS) You're not a geologist,
 11 correct?
 12 A I am not a geo --
 13 Q You're --
 14 A -- logist.
 15 Q -- not a mineralogist, correct?
 16 A I am not.
 17 Q You have reviewed some expert reports from
 18 Dr. Longo; is that right?
 19 A Among others, yes.
 20 Q You have reviewed some testing reports.
 21 Some purportedly show that there is asbestos present
 22 in talcum powder and some that show that there's not
 23 asbestos in talcum powder; is that right?
 24 MS. O'DELL: Object to the form.
 25 A I have seen a lot of reports that have

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1 shown the presence of talcum powder containing
2 asbestos and fibrous talc.
3 You listed some of those, the Longo
4 reports, a bunch of publications in the literature
5 such as Blount's.
6 I have seen some testing from Dr. Hopkins,
7 from Imerys, from Cooke. I have also seen some
8 negative reports.
9 Q (BY MR. ZELLERS) The answer to my question
10 is: Yes, you have seen testing that purportedly
11 shows there to be some asbestos in the J&J
12 manufactured talcum powder and you have seen reports
13 that, you know, indicate there's not asbestos in the
14 talcum powder; is that fair?
15 A The way that you have described it makes
16 it seem like I have seen comprehensive reports that
17 have shown in totality there is asbestos and reports
18 that have shown there's not. I haven't seen that.
19 Q All right.
20 A I have seen reports that have shown in
21 totality there are. I have seen individual samples
22 that have shown there's not asbestos in those
23 individual samples.
24 But I haven't seen a systematic report
25 that have shown in, for example, a large number of

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1 specimens, none had asbestos. I haven't seen that.
2 Q You have seen, at least in large part, the
3 information that's been provided to you by
4 plaintiffs' attorneys; is that right?
5 MS. O'DELL: Object to the form. to the
6 form.
7 A I think some of the public -- published
8 literature was not provided by plaintiff attorneys
9 and some has been, such as the Longo reports.
10 MR. ZELLERS: All right.
11 MS. O'DELL: Mike, we have been going
12 about an hour and 30 minutes. And our lunch is
13 here, so is this a good time.
14 MR. ZELLERS: Sure --
15 MS. O'DELL: -- for a break?
16 MR. ZELLERS: -- of course.
17 THE VIDEOGRAPHER: This marks the end of
18 Disc 2. We are off the record at 12:37 p.m.
19 (A break was taken from 12:37 p.m. to
20 1:36 p.m.)
21 THE VIDEOGRAPHER: We are back on the
22 record. This marks the beginning of Disc No. 3 in
23 the deposition of Dr. Rebecca Smith-Bindman. The
24 time is 1:36 p.m.
25 MR. ZELLERS: Dr. Smith-Bindman, let's go

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1 off the record for a moment.
2 THE VIDEOGRAPHER: We're off the record at
3 1:36 p.m.
4 (A break was taken from 1:36 p.m. to
5 1:37 p.m.)
6 THE VIDEOGRAPHER: We are back on the
7 record. The time is 1:37 p.m.
8 Q (BY MR. ZELLERS) Dr. Smith-Bindman, you
9 had recalled, I believe, the name of the fourth
10 plaintiff lawyer that you met with?
11 A Carmen Scott.
12 Q I want to ask you some questions about the
13 systematic review that you did. You have not
14 published that, correct?
15 A I have not.
16 Q If at any point you do publish your
17 systematic review, would you disclose that you are a
18 paid expert for the Plaintiffs in the talcum powder
19 litigation?
20 A Yes, I would.
21 Q You would expect any expert who is paid to
22 perform a review or who has a study funded by
23 Plaintiffs to make that disclosure, correct?
24 MS. O'DELL: Object to the form.
25 A My understanding from my experience is

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1 that different journals require different
2 disclosures. So if you're paid by someone, you
3 typically would have to disclose, but the detail
4 would -- would vary by journal.
5 Q (BY MR. ZELLERS) What methodology or
6 methodologies did you use to arrive at your opinion
7 that regular use of talcum powder increases a
8 woman's risk of developing invasive serous cancer by
9 about 50 percent?
10 A So I would say there were two parts. The
11 first part is my systematic review of the published
12 literature. I think I mentioned earlier that I have
13 published several systematic reviews.
14 And the mechanism of perform -- performing
15 those systematic reviews are both ones that I have
16 personally used and ones that I was involved in
17 developing the methodology as part of my work on the
18 Cochrane collaboration.
19 So it involves doing a very standardized
20 search, creating an approach for abstracting data,
21 abstracting the data. An approach that I used for
22 summarizing the data, which usually is looking at
23 stratified results, results in sort of specific
24 categories as opposed to broad categories.
25 Statistically summarizing the results and showing

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<p>1 them.</p> <p>2 So part of my conclusion was based on my</p> <p>3 own systematic review. And then part of my</p> <p>4 conclusion was based on my review of the published</p> <p>5 literature on the actual epidemiology data, as well</p> <p>6 as other considerations that went into consideration</p> <p>7 of the Bradford Hill criteria such as mechanistic</p> <p>8 data and any other requirements of Bradford Hill.</p> <p>9 Q Tell us step by step how you performed</p> <p>10 your systematic review or analysis. And now I'm</p> <p>11 referring to the meta-analysis or meta-analysis-like</p> <p>12 review that you did.</p> <p>13 A Okay. So I would just like to do a slight</p> <p>14 preamble to that, which is that the direction that</p> <p>15 my review took was partly informed by having read</p> <p>16 through a number of articles on the topic. So</p> <p>17 determining sort of where there was a gap, what was</p> <p>18 the most important area to focus on. So that sort</p> <p>19 of was the background.</p> <p>20 And then for the review, the literature</p> <p>21 search is the first step. So you want to broadly</p> <p>22 identify all relevant literature, published and</p> <p>23 unpublished, to include.</p> <p>24 And that includes searching on several</p> <p>25 databases -- PubMed was -- Medline were -- Embase,</p>	<p>1 through those and to review to make sure that they</p> <p>2 had primary data.</p> <p>3 So I was only interested in studies that</p> <p>4 had primary data, which meant that review articles</p> <p>5 or editorials or letters to the editors or opinion</p> <p>6 pieces were dropped from that list.</p> <p>7 So then I had data that were -- I had</p> <p>8 studies that had primary data, so that became my</p> <p>9 list of articles.</p> <p>10 And -- and then I created a data</p> <p>11 abstraction form for what variables I wanted to</p> <p>12 include. So some variables are the number of cases;</p> <p>13 the number of controls; the kind of study design</p> <p>14 whether it was a case-control study or another</p> <p>15 design.</p> <p>16 It included -- included the groups that I</p> <p>17 cared most about. So you mentioned serous cancer,</p> <p>18 so I included what kind of histologies they looked</p> <p>19 at.</p> <p>20 I included in my initial data form,</p> <p>21 variables that I ended up not using in my review</p> <p>22 because I didn't have enough data.</p> <p>23 So in my initial draft of variables that I</p> <p>24 might like to abstract was the relationship in pre</p> <p>25 versus postmenopausal women.</p>
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<p>1 Scopus were -- were databases that I started my</p> <p>2 search.</p> <p>3 I included in the report some of the</p> <p>4 keywords I used, keywords including "ovarian cancer,</p> <p>5 talc, perineal powder, genital powder."</p> <p>6 So I generated a long list of articles</p> <p>7 that I retrieved and then reviewed the references</p> <p>8 for each of those articles, which usually doesn't</p> <p>9 identify a lot more articles, but usually identifies</p> <p>10 a few that I may have missed in my search, but that</p> <p>11 other people have found in their reviews or</p> <p>12 systematic reviews. So the first step was to</p> <p>13 identify the literature.</p> <p>14 Q What was the next step? And again, I'm</p> <p>15 focused on your methodology for the systematic</p> <p>16 review or analysis that you did, as reflected in</p> <p>17 your report?</p> <p>18 A So the second step is: Identified a large</p> <p>19 number of publications, but some of them may not</p> <p>20 have been particularly relevant.</p> <p>21 For example, they may have sounded in the</p> <p>22 title like they were primary data, but they may have</p> <p>23 actually only been review data.</p> <p>24 So Step 2 is to review the abstracts for</p> <p>25 all of those identified articles and then to go</p>	<p>1 But when I ended up reviewing articles,</p> <p>2 there just was not -- not enough data there to make</p> <p>3 sense of, so I created a data abstraction form.</p> <p>4 I then went one by one through the</p> <p>5 articles which I organized and abstracted the data</p> <p>6 that I had set out to do.</p> <p>7 And in the course of doing that, I would</p> <p>8 ensure that the participants that were described in</p> <p>9 those reports were, in fact, unique subjects.</p> <p>10 So within this field, just like many</p> <p>11 fields, people sometimes publish an individual</p> <p>12 patient in more than one study. And -- and you</p> <p>13 don't want to include that, if you can.</p> <p>14 So as part of my review was to determine</p> <p>15 how independent the patients were and to make a note</p> <p>16 if there was overlap.</p> <p>17 I also didn't mention some of the features</p> <p>18 that I abstracted. But it wasn't just the primary</p> <p>19 result, which was what was the adjusted odds ratio</p> <p>20 or risk ratio associated with exposure to talcum</p> <p>21 powder products, but it was also -- what I was most</p> <p>22 interested in is quantifying that exposure to a</p> <p>23 degree that had not been present in all the</p> <p>24 individual reviews that I had previously said. So I</p> <p>25 was interested primarily in abstracting data on</p>

<p style="text-align: right;">Page 150</p> <p>1 regular exposure to talcum powder.</p> <p>2 So when I went through the articles, I</p> <p>3 noted whether -- what the point estimates were, but</p> <p>4 also whether they had information on all of the</p> <p>5 things that were in my database.</p> <p>6 I went through and abstracted data several</p> <p>7 times.</p> <p>8 Q Okay. Well, that's --</p> <p>9 A Oh.</p> <p>10 MS. O'DELL: She may not be done but --</p> <p>11 Q (BY MR. ZELLERS) Well, I understand. So</p> <p>12 I'm just trying to go through your methodology here.</p> <p>13 So after you abstracted the data and</p> <p>14 included it or put it on your data abstraction form</p> <p>15 for each study, what was the next step in your</p> <p>16 systematic review?</p> <p>17 MS. O'DELL: So just continue on, Doctor,</p> <p>18 what your process was.</p> <p>19 A Okay. Well -- so the next step was to</p> <p>20 decide which -- which of those papers might have</p> <p>21 been missing data.</p> <p>22 So once I abstracted the data, there were</p> <p>23 gaps almost certainly in the data. And so I -- I</p> <p>24 just wanted to emphasize -- I was starting to say</p> <p>25 this earlier -- that I -- I went back to the papers</p>	<p style="text-align: right;">Page 152</p> <p>1 Q That's what Dr. Hall did; is that right?</p> <p>2 A That is what Dr. Hall did. I should have</p> <p>3 a caveat there. We -- she absolutely lead that part</p> <p>4 of the analysis, but I reviewed every step of that</p> <p>5 very carefully.</p> <p>6 And there were several places that I --</p> <p>7 I -- I saw errors in some of the calculations that</p> <p>8 we went back and forth on to correct those</p> <p>9 calculation errors.</p> <p>10 Q Have you completed your methodology or the</p> <p>11 different steps in your methodology?</p> <p>12 MS. O'DELL: In terms of the</p> <p>13 meta-analysis?</p> <p>14 Q (BY MR. ZELLERS) Yes. In terms of the</p> <p>15 systematic review or meta-analysis that you did.</p> <p>16 A I believe I have highlighted all the</p> <p>17 steps.</p> <p>18 Q You tried or did correct any errors in</p> <p>19 calculations or numbers by Dr. Hall; is that right?</p> <p>20 MS. O'DELL: Object to the form.</p> <p>21 A Yes, I did.</p> <p>22 Q (BY MR. ZELLERS) Did anyone else review</p> <p>23 your calculations and Dr. Hall's calculations?</p> <p>24 A No. Just the two of us.</p> <p>25 You said something, that I corrected some</p>
<p style="text-align: right;">Page 151</p> <p>1 and tried to sort of ensure that I was consistently</p> <p>2 pulling the data in my database requirement for</p> <p>3 every study.</p> <p>4 After I did that, the next step would be</p> <p>5 to combine the data statistically. And that would</p> <p>6 be to pro -- perform steps to figure out how the</p> <p>7 data can be -- could be combined.</p> <p>8 And that required looking at issues of</p> <p>9 consistency across the studies or heterogeneity and</p> <p>10 then to make sure that the sub analysis that I</p> <p>11 wanted to do -- the stratified analysis that I</p> <p>12 wanted to do could be done based on whether I had</p> <p>13 data for each of those studies in the stratified</p> <p>14 category.</p> <p>15 So as an example, I wanted to make sure</p> <p>16 that I -- I had whatever information was in the</p> <p>17 paper that could then go to the next step of</p> <p>18 analysis.</p> <p>19 And so that's when, actually, I reached</p> <p>20 out to a biostatistician with -- expert in the</p> <p>21 biostatistical aspect to do two things: To both</p> <p>22 double-check my numbers and ensure that the numbers</p> <p>23 that -- had been abstracted correctly and then to do</p> <p>24 the biostatistical analysis and generate the</p> <p>25 graphical representation of the data.</p>	<p style="text-align: right;">Page 153</p> <p>1 of her numbers. I -- she also corrected some of my</p> <p>2 numbers.</p> <p>3 It was a bi-directional two set of eyes on</p> <p>4 all of the analysis --</p> <p>5 Q I --</p> <p>6 A -- and abstractions.</p> <p>7 Q -- essentially what you did is you</p> <p>8 analyzed the studies. You abstracted data on each</p> <p>9 of the studies on your Data Abstraction Form,</p> <p>10 correct?</p> <p>11 A Yes.</p> <p>12 Q Have you produced your Data Abstraction</p> <p>13 Forms to us for review?</p> <p>14 A I -- I believe I have.</p> <p>15 Q All right. You have them available; is</p> <p>16 that right?</p> <p>17 A Yes.</p> <p>18 Q And this would be a form for each of the</p> <p>19 studies in which you went through and you abstracted</p> <p>20 data; is that right?</p> <p>21 A It's --</p> <p>22 MS. O'DELL: Object to the form. Sorry.</p> <p>23 Go ahead.</p> <p>24 A -- yeah, it's -- it's an electronic</p> <p>25 database. It's an Excel file.</p>

<p style="text-align: right;">Page 154</p> <p>1 Q (BY MR. ZELLERS) But there would be a form 2 or an Excel sheet for each of the studies where you 3 abstracted the data; is that right? 4 MS. O'DELL: Object to the form. 5 A There's an Excel sheet with each study 6 listed as a separate line of data and many, many 7 rows -- columns for each -- it's not a physical 8 piece of paper and... 9 Q (BY MR. ZELLERS) But it's something that 10 could be printed out; is that right? 11 A Yes. 12 Q All right. Did you develop any type of 13 protocol setting forth the different steps that you 14 followed to do your systematic analysis that you 15 have told us about? 16 A The protocol that I followed for these 17 steps is a very well-established, well-published -- 18 including by myself from any prior reviews -- 19 protocols. 20 Q My question is: Did you write down 21 anywhere, the protocol that you followed for doing 22 this particular systematic review? 23 MS. O'DELL: Object to the form. 24 A I did not specifically write down for this 25 review that I would do a literature search or</p>	<p style="text-align: right;">Page 156</p> <p>1 times week or more as possible and that I would 2 focus on invasive serous cancer wherever possible. 3 And so if that -- if that's what you mean 4 by my "protocol," then yes, that was written down 5 ahead of time. 6 Q (BY MR. ZELLERS) I'm confused. Do you 7 define -- well -- and No. 1, did you produce that 8 protocol? 9 A So I have -- I have my notes and -- which 10 was part of the documents that you saw earlier 11 today. 12 Q The notes, you would describe as your 13 protocol or an outline of your methodology? 14 A Yes. 15 Q All right. We'll mark your notes, which 16 are your protocol, as Exhibit 21. 17 (Exhibit 21 was marked for identification 18 and is attached to the transcript.) 19 Q (BY MR. ZELLERS) And it's just the one 20 side sheet; is that right? 21 A I believe I provided other documents in 22 the datasheet that also has the notes of what group 23 I was focusing on in e-mails that I have sent you. 24 Q That would be other materials that you 25 have produced; is --</p>
<p style="text-align: right;">Page 155</p> <p>1 abstract data and record points and then do the 2 analysis. 3 Q (BY MR. ZELLERS) What you have done in 4 your systematic review is a subgroup analysis of 5 those studies that you thought should be included; 6 is that fair? 7 A I call it a stratified analysis rather 8 than a subgroup analysis. Usually a subgroup 9 analysis is usually used to describe only limiting 10 to certain groups of patients as opposed to some 11 questions. So I -- I'm not sure that there's a 12 distinction but... 13 Q Well, you -- whether we call it a subgroup 14 or whether we call it a stratified analysis, you 15 went through the studies to try to find the studies 16 that would give you information on women who were 17 regular users, as you defined "regular users," and 18 who developed invasive serous ovarian cancer, 19 correct? 20 MS. O'DELL: Object to the form. 21 A Yes, that's what I did. 22 When you asked about whether I have a 23 protocol written down, I have written that I was 24 going to abstract information about regular use of 25 talc powder products defined as closely as three</p>	<p style="text-align: right;">Page 157</p> <p>1 A That's -- 2 Q -- the right? 3 A -- correct. 4 Q To your knowledge, there's nothing that 5 you have not produced -- 6 A No. 7 Q -- relating -- hold -- 8 A Okay. 9 Q -- on. Let me finish. 10 There's nothing, to your knowledge, that 11 you have not produced relating to your analysis; is 12 that right? 13 A That's correct. 14 Q I was confused. I thought you stated a 15 moment ago that you defined "regular use" as the use 16 of talcum powder three times a week or more. 17 Is that your definition of "regular use"? 18 A I -- 19 MS. O'DELL: Object to the form. 20 A -- I describe the definition in my report 21 on page 32. And -- 22 Q (BY MR. ZELLERS) My question just is: Is 23 that the correct definition or did you use a 24 different definition of "regular use"? 25 MS. O'DELL: Object to the form. You may</p>

<p style="text-align: right;">Page 158</p> <p>1 describe your --</p> <p>2 A So I -- I --</p> <p>3 MS. O'DELL: -- definition.</p> <p>4 A -- have listed how I have defined it. And</p> <p>5 it's a little bit more -- more nuanced than what you</p> <p>6 have just asked me to confirm.</p> <p>7 Q (BY MR. ZELLERS) What is your definition</p> <p>8 of "regular use" with respect to the systematic</p> <p>9 review and analysis that you did?</p> <p>10 A So I have written, Regular use was defined</p> <p>11 ideally as daily or at least more than three uses</p> <p>12 per week.</p> <p>13 Q More than three uses a week; is that</p> <p>14 right?</p> <p>15 A I -- I wasn't finished. May I finish?</p> <p>16 Q Sure.</p> <p>17 A "I also accepted studies that defined</p> <p>18 "use" as regular where the description made it clear</p> <p>19 that this was regular use.</p> <p>20 A study that reported regular use, but</p> <p>21 defined it as less -- as used less frequency --</p> <p>22 at -- use of less than as -- frequency were not</p> <p>23 included.</p> <p>24 Regular use was selected to differentiate</p> <p>25 occasional use, which may include one-time</p>	<p style="text-align: right;">Page 160</p> <p>1 A -- page --</p> <p>2 MS. O'DELL: -- go ahead.</p> <p>3 A -- 32.</p> <p>4 Q (BY MR. ZELLERS) You have defined "regular</p> <p>5 use" in your report on page 32; is that right?</p> <p>6 A Yes.</p> <p>7 Q What is Dr. Hall's field of expertise?</p> <p>8 A She is a biostatistician who is -- does a</p> <p>9 lot of summaries of systematic review.</p> <p>10 Q You are not a biostatistician; is that</p> <p>11 right?</p> <p>12 A I did a two-year post-graduate fellowship</p> <p>13 in the Department of Epidemiology and Biostatistics,</p> <p>14 have taken many courses in biostatistician --</p> <p>15 biostatistics, and have thought classes in biostatistics</p> <p>16 --</p> <p>17 Q Do you con --</p> <p>18 A -- statistics.</p> <p>19 Q -- do you consider yourself to be an</p> <p>20 expert biostatistician?</p> <p>21 A I consider myself an expert in</p> <p>22 biostatistics.</p> <p>23 Q And Dr. Hall is also an expert in</p> <p>24 biostatistics; is that right?</p> <p>25 A Yes.</p>
<p style="text-align: right;">Page 159</p> <p>1 infrequent use or used along a particular time of a</p> <p>2 woman's menstrual cycle from sustained use.</p> <p>3 Studies that ask participants a single</p> <p>4 question about every use of talc without further</p> <p>5 quantification of exposure were not included for the</p> <p>6 summary.</p> <p>7 For example, Perdue reported that 52 to</p> <p>8 57 percent of women ever using talc without further</p> <p>9 quantification was not included."</p> <p>10 THE COURT REPORTER: Please slow down.</p> <p>11 Q (BY MR. ZELLERS) Okay.</p> <p>12 A Yes.</p> <p>13 Q Doctor, I just wanted to know your</p> <p>14 definition of "regular use."</p> <p>15 A I -- I -- I have spent considerable time</p> <p>16 both writing my definition and applying it to --</p> <p>17 Q What --</p> <p>18 A -- the papers.</p> <p>19 Q -- what page --</p> <p>20 MS. O'DELL: Excuse me, sir. If you were</p> <p>21 asking for the page, she can direct you to the page</p> <p>22 --</p> <p>23 Q (BY MR. ZELLERS) What page --</p> <p>24 A So --</p> <p>25 MS. O'DELL: Doctor --</p>	<p style="text-align: right;">Page 161</p> <p>1 Q Do you know -- well, did you conduct your</p> <p>2 systematic review and analysis using the PRISMA</p> <p>3 standards?</p> <p>4 A Yes.</p> <p>5 Q And those are the preferred reporting</p> <p>6 items for systematic reviews and meta-analyses; is</p> <p>7 that right?</p> <p>8 A Yes.</p> <p>9 Q What materials did you provide to Dr. Hall</p> <p>10 to assist you with your review?</p> <p>11 A I provided her with the data abstraction</p> <p>12 table that had information about each of the</p> <p>13 included studies.</p> <p>14 Q The data abstraction table that you</p> <p>15 prepared; is that right?</p> <p>16 A Yes.</p> <p>17 Q What specifically did Dr. Hall do to</p> <p>18 assist you?</p> <p>19 A She did two things. She personally</p> <p>20 reabstracted data from all of the publications.</p> <p>21 Most of those publications she found on her own.</p> <p>22 But for a couple, she was not able to find them, and</p> <p>23 I provided electronic versions of them.</p> <p>24 And then she statistically combined and</p> <p>25 compared the study to assess for heterogeneity to</p>

<p style="text-align: right;">Page 162</p> <p>1 calculate forest plots and summary-weighted 2 estimates. 3 Q What could Dr. Hall do with respect to 4 your analysis that you could not? 5 A I did not know how to use the software to 6 generate the graphs. And I thought that by the time 7 I learned how to use that software, it would be a 8 lot more efficient for her to generate them. 9 Q What did you do to check Dr. Hall's work 10 to make sure it was accurate? 11 A Dr. Hall sent me back my data abstraction 12 database where she had double-checked all of my 13 numbers and sent -- I think there were several data 14 points where she had questions about either whether 15 I abstracted the right number or put it in the right 16 category. 17 And of all of the items that she had 18 suggestions -- I think it was a small number -- I 19 went back to the original article to -- to confirm 20 or refute whether I agreed with her changes or not. 21 Sort of a way to -- by consensus to decide what the 22 right answer was. That was part of what I did. I 23 -- 24 Q How -- did you finish? 25 A -- no.</p>	<p style="text-align: right;">Page 164</p> <p>1 A I would not do it in that order. I -- I 2 generated the research questions first. 3 Q (BY MR. ZELLERS) You generated the 4 research questions after doing the initial 5 literature review you told us about this morning, 6 correct? 7 A I -- 8 MS. O'DELL: Object to the form. 9 A -- yes. 10 Q (BY MR. ZELLERS) All right. You 11 identified ten studies that discuss what you define 12 as "regular talc powder product use and risk of 13 ovarian cancer," and those are what you list on a 14 page 33 of your report; is that right? 15 A That's close to correct. I would include 16 in that another study, the Terry study, which is a 17 large study that pulls data from a bunch of other 18 component studies -- you can see on the top of 19 page 34 -- whether or not Terry was included or 20 excluded. The results were basically identical. 21 Q I'm just looking at your report. Your 22 report, on page 33, in Figure 2, you identify ten 23 studies that discuss what you define as "regular 24 talc powder product use and risk of ovarian cancer," 25 correct?</p>
<p style="text-align: right;">Page 163</p> <p>1 Q All right. Well, finish. 2 A She also generated -- she -- we went back 3 and forth. She had a bunch of questions. 4 But she also generated summary estimates. 5 And there were a bunch of categories that I asked 6 her to do. Some of those summary estimates, to me, 7 seemed like they didn't totally make essence. 8 So one analysis used seven studies and one 9 used nine, but it had the same final odds ratio out 10 to three digits. And it should have been the same 11 result perhaps, but not out to three digits. 12 So I went through those and sort of said: 13 Look, can you redouble-check this to make sure that 14 the weighting was correct? 15 And in one or two cases she came back and 16 said: No, the weighting was not correct. 17 So I rechecked every graph and every 18 number that she generated. 19 Q Ultimately, you identified -- let me 20 withdraw that. 21 You reviewed the studies; you did your 22 data abstraction; and you formulated your research 23 question or questions for the systematic review, 24 correct? 25 MS. O'DELL: Object to the form.</p>	<p style="text-align: right;">Page 165</p> <p>1 MS. O'DELL: Object to the form. 2 A So that -- that paragraph is continued on 3 page 34, the next page at the top which says, The 4 primary analysis of this excluded Terry, but the 5 results were nearly identical if Terry was included. 6 Q (BY MR. ZELLERS) You could have included 7 Terry as part of Figure 2, and that would have been 8 an 11th study; is that right? 9 A Yes, that's correct. 10 Q Why did you not include Terry in your 11 analysis and -- in Figure 2? 12 A Terry included, within its -- within her 13 assembled papers, other patients that are already 14 included in Figure 2. 15 And including Terry would have listed -- 16 would have weighted some patients more than once. 17 Q Is there, to your knowledge, any 18 duplication or overlap in the patients for the ten 19 studies that you list in Figure 2 on page 33 of your 20 report? 21 A To the degree that I could eliminate 22 overlap, I did. 23 Q Is there overlap in some of the patients 24 and some of the studies? 25 A I would have to look at it again to remind</p>

<p style="text-align: right;">Page 166</p> <p>1 myself if there is any overlap. I -- I don't 2 believe there is. 3 And any overlap, I made every effort to 4 get rid of. I would have to look at those papers a 5 little bit more closely to remember if there was any 6 overlap. 7 I -- I know there was a lot of overlap if 8 I included Terry, which is why that was an important 9 exclusion. 10 Q How did you identify these ten studies 11 that you list in Figure 2? 12 A So I -- I did not identify those studies. 13 That was what -- Dr. Hall used the data that I 14 provided -- to identify which studies had the -- the 15 appropriate data to look at -- look at this. 16 Q How did Dr. Hall identify these ten 17 studies as being the ones to include in Figure 2? 18 A These were the studies that had data on 19 daily talc powder -- powder products. 20 Q You only used subsets of data from these 21 ten studies -- those ten studies listed in 22 Figure 2 -- to reach your conclusions, correct? 23 MS. O'DELL: Object to the form. 24 A I don't remember offhand if I used all of 25 the data from these studies or subsets of data from</p>	<p style="text-align: right;">Page 168</p> <p>1 A I -- I would not -- the individual studies 2 are shown with the confidence interval around those 3 point estimates. 4 One way to establish statistical 5 significance is -- is that statistically different 6 within an individual study than one. 7 But I don't believe that only two of these 8 show statistical significance as a group of studies. 9 So if you're asking if two don't overlap one, then I 10 would agree with you. If you're asking if these 11 together show statistical -- 12 Q (BY MR. ZELLERS) I'm going to ask you -- 13 MS. O'DELL: Excuse me. Sorry. Let her 14 finish. Sorry. 15 Q (BY MR. ZELLERS) Did you finish? 16 A I -- I'm trying to understand if you're 17 asking me if the original studies here show -- or 18 if -- just each line by itself. 19 Q If we go line by line for these ten 20 studies, only two of these ten studies demonstrate 21 statistical significance; is that right? 22 A Yes. 23 Q Yet you conclude by looking at all ten of 24 the studies that there is statistical significance; 25 is that right?</p>
<p style="text-align: right;">Page 167</p> <p>1 these studies to reach my conclusion. 2 There were only data from these ten 3 studies included in this figure, but I'm not sure if 4 I used all of the data from those studies or 5 subsets, as you asked. 6 Q (BY MR. ZELLERS) Would you agree that only 7 two of the ten studies in Figure 2 demonstrates 8 statistical significance? 9 A I would agree that taken altogether, these 10 studies show statistical significance. But I think 11 you're asking if they weren't taken together, if the 12 original studies were used, would those individual 13 studies show statistical significance? Is that what 14 you are asking? 15 Q No. You have listed out ten studies in 16 Figure 2; is that correct? 17 A Yes. 18 Q You are not aware whether you used all of 19 data from those studies for your systematic review 20 and analysis or subsets of the data, correct? 21 MS. O'DELL: Object to the form. 22 A Yes, that is correct. 23 Q (BY MR. ZELLERS) Would you agree that only 24 two of the ten studies in Figure 2 demonstrate 25 statistical significance?</p>	<p style="text-align: right;">Page 169</p> <p>1 A So the way you're asking the question 2 suggests that when you're combining studies in a 3 systematic review, you care about the initial sample 4 size of the question. 5 And so I conclude taken as a group of 6 studies, the individual sample size or power of the 7 individual associations is not sufficient to come up 8 with a narrow confidence interval. 9 And the width of the confidence interval 10 suggests that while the point estimate is greater 11 than one, the confidence interval overlaps one, 12 meaning you can't be sure if it's significantly 13 significant. 14 But the purpose of the systematic review 15 is to combine those studies together. So combining 16 them together gives a very powerful, positive 17 estimate that's very different than one. 18 Q Okay. 19 MR. ZELLERS: Move to strike as 20 nonresponsive. 21 Q (BY MR. ZELLERS) My question is: When you 22 looked at the ten studies together, you determined 23 that there was statistical significance; is that 24 right? 25 A Yes.</p>

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1 Q How did you make that calculation? How
 2 did you calculate statistical significance from
 3 those ten studies?
 4 MS. O'DELL: Object to the form. I
 5 believe she has already answered that, but you may
 6 describe that again, Doctor.
 7 A So the software that was used, is that
 8 what you are asking?
 9 Q (BY MR. ZELLERS) I want to know how it is
 10 that you calculated that these ten studies -- eight
 11 of which did not demonstrate statistical
 12 significance when they were looked at together --
 13 were statistically significant?
 14 A So I need to provide you with just a
 15 little background on the field of systematic reviews
 16 to answer that question.
 17 Q All right. Well, try to be as direct as
 18 you can, because I have only got a certain amount of
 19 time.
 20 Are you able to answer the question?
 21 A Absolutely.
 22 Q Then please tell us how you calculated
 23 statistical significance for the RE model.
 24 A So we looked at adjusted odds ratios of
 25 each of the studies. We weighted them based on the

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1 standard errors for each of them and calculated sort
 2 of an overlying association when basically the size
 3 of each study, the point estimate of each study were
 4 taken into consideration.
 5 So taking them altogether, it allows the
 6 summary estimate, if you look, to have a much
 7 narrower confidence interval than the individual
 8 study.
 9 So you use the weight of all the studies
 10 to combine the -- to give you a summary estimate.
 11 Q Where can I see the weighting and the
 12 calculation that you did to come up with the
 13 statistically significant number?
 14 A So the -- the name of the software we used
 15 was in Metafor package in R. "R" is a program.
 16 The data set that I provided to you of the
 17 extracted database, if you put those numbers -- if
 18 anyone puts those numbers in the Metafor package in
 19 R and instructs the software that you want to apply
 20 a -- linear mixed models to study that data set, you
 21 will get the exact same estimate that I got.
 22 Q And I will be able to see that from the
 23 documents that you have produced; is that right?
 24 A Absolutely.
 25 Q How did you calculate the confidence

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1 interval around the odds ratio for each of these ten
 2 studies?
 3 MS. O'DELL: Object to the form.
 4 A So most of the studies, if not all of
 5 those, would have had published adjusted odds ratios
 6 in the original calculations.
 7 I believe one of the studies, the Gertig,
 8 was an adjusted risk ratio, not an odds ratio, which
 9 had a bit of back-and-forth discussion with the
 10 biostatistician.
 11 And we decided they were essentially
 12 equivalent. But the other ones would have been
 13 extracted from the initial studies.
 14 Q The confidence intervals for the ten
 15 studies on -- in Figure 2, page 33 of your report
 16 came from the studies themselves?
 17 A Yes.
 18 Q Were there any other selection criteria
 19 that you used to identify these ten studies, other
 20 than what you have testified to?
 21 A No.
 22 Q Of the 43 or so studies that had primary
 23 data, are these the only studies, other than Terry,
 24 that discuss regular use of talc?
 25 A So I am just looking for where my fullest

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1 of studies is in the report. I think it's pages 23
 2 and 24.
 3 The fullest of studies that I looked at
 4 included -- I think there were seven systematic
 5 reviews. So the systematic reviews did not
 6 contribute to the -- they were not eligible for --
 7 for -- for my own review because they didn't have
 8 primary data, and they would overlap.
 9 And the same thing with -- well, the
 10 Terry, we know about. So it was only the other
 11 studies that were eligible.
 12 Q These ten studies that you list in
 13 Figure 2 are the only studies that you reviewed that
 14 discuss regular use of talc, and that's why you
 15 included them here; is that right?
 16 MS. O'DELL: Object to the form.
 17 A No, that's -- that's not what I said.
 18 The systematic reviews I read and had
 19 data, many of them, on regular use of talc.
 20 But those were not included in my
 21 systematic review because that would have had
 22 overlap of -- of -- of patients. So they were not
 23 included because it overlapped patients.
 24 Q (BY MR. ZELLERS) Which studies were those
 25 seven?

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1 A So they're listed on page 23 as systematic
2 reviews. So Penninkilampi and Berge and the IARC
3 and Langseth and Huncharek and Gross and Harlow.
4 The reason Terry was pulled out from that
5 to possibly include was because Terry provided new
6 data points that weren't included in the component
7 studies, and so I wanted to make sure not to miss
8 those patients.
9 But these other systematic reviews were
10 all covered in the other primary studies that I
11 included.
12 Q Why did you not include the Cramer study,
13 1999?
14 A Cramer was one of the authors that had a
15 lot of patients that kept appearing in subsequent
16 publications. So he published the same patients
17 more than once, so --
18 Q What analysis did you do to determine that
19 there was overlap between any of the patients
20 reported on by Cramer in 1999 and any of the ten
21 studies that you did choose to include?
22 A I went through -- I think there's a
23 separate page in my data fields that's just
24 attributed to the Cramer studies -- and wrote down
25 what years of enrollment the patients were.

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1 And to the best I could, I identified the
2 cohorts and then pulled them out to only identify
3 all patients once, which -- which is the reason I
4 hesitated to say there was no overlap.
5 But I did my best to only include every
6 patient once. And --
7 Q Okay.
8 A -- Cramer got his own worksheet because it
9 was trickier to figure out.
10 Q Cramer 1999 you did not include in your
11 systematic review because you analyzed that paper
12 and the other studies and determined that there was
13 overlap; is that right?
14 A I didn't quite say that. I'm saying that
15 I was very careful not to include overlap patients.
16 I don't know why Cramer 1999 didn't make it into the
17 review.
18 Q I --
19 A I don't know if he didn't have regular use
20 of talc or -- I -- I -- you know, I would have to --
21 to figure out why it wasn't included.
22 Q Well, take a look at the Cramer 1999
23 paper, which we'll mark as Exhibit 22.
24 (Exhibit 22 was marked for identification
25 and is attached to the transcript.)

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1 Q (BY MR. ZELLERS) If you turn to --
2 MS. O'DELL: I'll take that.
3 Q (BY MR. ZELLERS) -- turn to Table 2 on
4 page 353, the bottom table -- at the bottom of the
5 table.
6 A Yes.
7 Q Do you see data with respect to "frequency
8 of use per month"?
9 A Yes.
10 Q That's the type of study and the type of
11 information that you did include in your systematic
12 review; is that right?
13 A Yes.
14 Q Is it fair to say that as you sit here
15 today, you just don't remember why you did not
16 include Cramer 1999?
17 MS. O'DELL: Object to the form.
18 A In looking at this, you have convinced me
19 it's not because he doesn't have frequency of use,
20 because there is frequency of use in here. I do not
21 know why it didn't make it into the final database.
22 But I'm looking at my paper from Cramer
23 from 2016, "The Association Between Talc Use and
24 Ovarian Cancer, a Retrospective Case-control Study."
25 He describes -- this is on page 334 of

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1 that other article -- that data came from three
2 enrollment phases.
3 And my notes on the side say "minus Cramer
4 '99," suggesting -- I don't mind showing you my
5 notes -- showing that there's overlap with Cramer
6 '99 --
7 Q Okay.
8 A -- so.
9 Q You -- do you believe that the reason you
10 did not include Cramer 1999 is because there was
11 overlap with the patients included in Cramer 2016 or
12 you're not sure?
13 A Yes.
14 MS. O'DELL: Object to the form.
15 Q (BY MR. ZELLERS) Which one is it?
16 MS. O'DELL: Object to the form.
17 A I -- I do not know why it wasn't included,
18 but I believe there was overlap with 2016, is why it
19 was not included.
20 Q (BY MR. ZELLERS) You also did not include
21 Rosenblatt 2011 in your systematic review; is that
22 right?
23 A Rosenblatt was included in the review.
24 But on much -- it looks like it didn't make it into
25 the final graph or the final group of ten.

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1 Q Why did it not make it into the final
2 graph or group of ten?
3 A So I don't -- let me just say I don't
4 remember why Rosenblatt was not included.
5 I specifically asked the biostatistician
6 to do the analysis with and without Rosenblatt, and
7 I believe the reason was -- I believe is that -- the
8 quality of Rosenblatt seems very poor, and I can't
9 remember why.
10 But I asked her to do the analysis with
11 and without Rosenblatt. I asked her to do, I think,
12 four different analyses with and without Terry, with
13 and without Rosenblatt.
14 My recollection is it had no impact. But
15 I do not remember why I asked her with the quality
16 issue -- I would have to go back to my database to
17 remember why I asked her to do it both ways.
18 Q Rosenblatt contained information over --
19 or strike that -- including a lifetime number of
20 applications and included information on more than
21 10,000 lifetime applications, correct?
22 A Yes.
23 Q All right.
24 A Well, I -- I'm -- I'm looking for it.
25 Yeah, I'm guessing that --

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1 Q Here is a --
2 MS. O'DELL: Don't -- don't. Excuse me --
3 yeah, don't guess. Just if you know.
4 A -- I --
5 Q (BY MR. ZELLERS) Exhibit 23 is Rosenblatt.
6 A I have got the paper.
7 MS. O'DELL: Yeah. Feel free to take a
8 moment. And if you need your original spreadsheets
9 to answer any of these detailed questions, then we
10 can pull those out for you --
11 A Okay.
12 MS. O'DELL: -- if counsel does not have a
13 copy for you.
14 Q (BY MR. ZELLERS) Just for the record,
15 Exhibit 23 is Rosenblatt.
16 (Exhibit 23 was marked for identification
17 and is attached to the transcript.)
18 Q (BY MR. ZELLERS) As you sit here, do you
19 know what the difference in results were if
20 Rosenblatt was included in your systematic review or
21 not?
22 A I -- I do.
23 MS. O'DELL: Object to the form.
24 Q (BY MR. ZELLERS) Okay. What is --
25 A I do.

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1 Q -- the difference in result?
2 A It -- it had no impact on the overall --
3 Q Was --
4 A -- results.
5 Q -- it exactly the same?
6 A It was within a decimal fraction of a
7 percent the same.
8 Q Can you tell us what the result was with
9 Rosenblatt included?
10 A It was the same with and without
11 Rosenblatt included --
12 Q Is --
13 A -- within a hundredth of a percent.
14 Q Did you produce that calculation for us?
15 A Within the files that I shared, it is
16 included in the forest plot tables that Dr. Hall
17 generated.
18 Q Go to Figure 2, if you will, in your
19 report, page 33. Do you have that?
20 MS. O'DELL: If you need to see the -- the
21 data that you produced, Doctor, the Excel
22 spreadsheets --
23 A Oh, that would be great.
24 MS. O'DELL: -- okay. And I -- I'm going
25 to hand you my computer. But it's --

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1 A Can I --
2 MS. O'DELL: -- it's the data --
3 A -- this is what I shared with you.
4 MS. O'DELL: -- and that's what she is
5 discussing.
6 Q (BY MR. ZELLERS) Yeah. I have a question
7 pending. If you can answer my -- if you need to
8 look at your counsel's computer to answer my
9 question, you can.
10 But my question is: Will you look at
11 Figure 2 on page 33 of your report.
12 MS. O'DELL: Just hang on. Just -- what
13 I'm showing the doctor is data that -- the tables
14 that she has been discussing, but you have not
15 provided to her, which would be the fair way to
16 examine here on them.
17 But this is the -- the information that
18 was produced to Defendants for purposes of
19 Dr. Smith-Bindman's, you know, deposition. So if
20 you need that, just -- you may refer to it.
21 Q (BY MR. ZELLERS) Are you ready,
22 Dr. Smith-Bindman?
23 A I'm close to ready, but not quite.
24 Q I -- I'm not sure what you are doing.
25 MS. O'DELL: Well, she is looking at the

<p style="text-align: right;">Page 182</p> <p>1 calculation that you were just asking her about.</p> <p>2 Q (BY MR. ZELLERS) I have finished those</p> <p>3 questions. She has answered those questions. I'm</p> <p>4 asking a new question. Or I would like to.</p> <p>5 A Okay. Thank you.</p> <p>6 MS. O'DELL: You're welcome. If you need</p> <p>7 to see any of the tables --</p> <p>8 A Okay.</p> <p>9 MS. O'DELL: -- Doctor, I have all that</p> <p>10 has been produced right here.</p> <p>11 A Fantastic.</p> <p>12 Q (BY MR. ZELLERS) Okay.</p> <p>13 Dr. Smith-Bindman -- Bindman, looking at Figure 2,</p> <p>14 looking at the confidence intervals that you have</p> <p>15 listed for each of those ten studies, are you aware</p> <p>16 that not one of those confidence intervals for any</p> <p>17 of the ten studies are actually listed in or come</p> <p>18 from the study publications?</p> <p>19 MS. O'DELL: Object to the form.</p> <p>20 A I am not aware of that.</p> <p>21 Q (BY MR. ZELLERS) In fact, did you</p> <p>22 recalculate the confidence interval for each of</p> <p>23 these studies?</p> <p>24 A The confidence intervals and the point</p> <p>25 estimate are adjusted confidence intervals and odds</p>	<p style="text-align: right;">Page 184</p> <p>1 (Exhibit 24 was marked for identification</p> <p>2 and is attached to the transcript.)</p> <p>3 Q (BY MR. ZELLERS) Is this another e-mail</p> <p>4 exchange between you and Dr. Hall? Is that yes?</p> <p>5 A I'm so sorry. I didn't hear your</p> <p>6 question.</p> <p>7 Q Sure. My question is: Is this an e-mail</p> <p>8 exchange between you and Dr. Hall?</p> <p>9 A Yes.</p> <p>10 Q If you look at the e-mail at the bottom of</p> <p>11 the second-to-last page, Dr. Hall writes you on</p> <p>12 Monday, September 24, 2018, at 11:42, and tells you</p> <p>13 that she is encountering obstacles; is that right?</p> <p>14 And I'm sorry. It's the third-to-last</p> <p>15 page is where that e-mail starts.</p> <p>16 A I see what you are saying. She has a note</p> <p>17 at the bottom of the page.</p> <p>18 Q She tells you she's encountering</p> <p>19 obstacles?</p> <p>20 A Yes.</p> <p>21 Q She asks you a number of questions?</p> <p>22 A Yes.</p> <p>23 Q No. 1 is that there's missing proportion</p> <p>24 information and the data is missing.</p> <p>25 If you go down to 1B, she says, Where the</p>
<p style="text-align: right;">Page 183</p> <p>1 ratios, so you -- you can't recalculate them from</p> <p>2 the data in the paper.</p> <p>3 Q My -- my question is: Who calculated</p> <p>4 these confidence intervals that appear in Figure 2?</p> <p>5 Did you calculate those confidence intervals?</p> <p>6 A To the best of my knowledge, these</p> <p>7 confidence intervals came from the primary</p> <p>8 publications.</p> <p>9 Q And -- and I will represent to you that I</p> <p>10 have looked at all of the primary publications and</p> <p>11 the confidence intervals that you have listed in</p> <p>12 Figure 2. None of those confidence intervals come</p> <p>13 from the publication.</p> <p>14 So do you have any idea as to how these</p> <p>15 confidence intervals were calculated?</p> <p>16 MS. O'DELL: If there's --</p> <p>17 A You would have to show me --</p> <p>18 MS. O'DELL: Yes.</p> <p>19 A -- those -- those disagreements for me to</p> <p>20 --</p> <p>21 Q (BY MR. ZELLERS) Well, let's --</p> <p>22 A -- to know what we're looking at.</p> <p>23 Q -- let's -- I'll get to that in just a</p> <p>24 second. Let me show you a couple of documents.</p> <p>25 Deposition Exhibit 24.</p>	<p style="text-align: right;">Page 185</p> <p>1 raw numbers are not available, I would do my best to</p> <p>2 estimate unless you have access to them and can send</p> <p>3 them to me.</p> <p>4 How did you respond to that question?</p> <p>5 A Can't we see what my answers were?</p> <p>6 Q Sure. Where are your answers? If you, in</p> <p>7 any of the documents that have been produced, can</p> <p>8 show us how you answered these questions, that would</p> <p>9 be helpful.</p> <p>10 MS. O'DELL: Object to the form.</p> <p>11 A I would like to just clarify something in</p> <p>12 her request, which is she is not asking me in this</p> <p>13 case for an estimate of the odds ratios or the</p> <p>14 confidence intervals, even although though it seems</p> <p>15 like she is.</p> <p>16 What she is asking for is an estimate of</p> <p>17 the sample size in terms of the N of cases and N of</p> <p>18 controls that can be used for weighting those</p> <p>19 studies in generating the summary estimate.</p> <p>20 So that's where she's trying to fill in</p> <p>21 the blanks, not for the odds ratios or confidence</p> <p>22 intervals, but to calculate -- calculate --</p> <p>23 calculate how -- how much weight it should be in the</p> <p>24 summary statistic.</p> <p>25 Q (BY MR. ZELLERS) How did you respond to</p>

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1 her first question where she advised you that there
 2 was missing proportion information and her proposal
 3 that "where the raw numbers are not available, I'll
 4 do my best to estimate, unless you have access to
 5 them and can send them to me"?
 6 MS. O'DELL: Object to the form; asked and
 7 answered.
 8 A I did not have, other than going to the
 9 papers, any additional information to supplement.
 10 Q (BY MR. ZELLERS) Okay. No. 2 --
 11 MS. O'DELL: Are you finished, Doctor?
 12 A Say it again.
 13 MS. O'DELL: Are you finished?
 14 A No.
 15 MS. O'DELL: Okay.
 16 A And so, again, she's not asking me about
 17 the abstraction. She's asking me if a study
 18 reported, for example, that there were a hundred
 19 patients with serous carcinoma or if there were
 20 150 patients altogether, it reported the odds ratios
 21 for serous carcinoma, but may not have specified in
 22 the table how many cases of serous carcinoma there
 23 were, could she estimate that proportion when we had
 24 the point estimate we needed.
 25 We had the odds ratio we needed, but she

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1 needed to know how many serous cancers there were to
 2 weight it.
 3 And I would have told her, when the raw
 4 numbers for those missing proportions were not
 5 available, to do her best to estimate those.
 6 Q (BY MR. ZELLERS) Did you respond to this
 7 e-mail?
 8 A I sent you all of the documents that I had
 9 for our correspondence.
 10 Q Okay.
 11 A I certainly could look again to see if I
 12 have an answer to this. Or it could be that we
 13 discussed the answers on the telephone.
 14 Q No. 2 --
 15 A Let me just see if we have -- if it says.
 16 I think we spoke on the telephone.
 17 Q Do you have any notes of that telephone
 18 conversation?
 19 A No, I don't.
 20 Q All right. No. 2, when she told you that
 21 she was unable to calculate the associated
 22 95 percent confidence intervals without the
 23 variants, which is not reported and she gave you
 24 three options, which option did you tell her to
 25 follow, if any?

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1 MS. O'DELL: Object to the form.
 2 A We discussed this at length, and she ended
 3 up going with Option 3, using relative risk as an
 4 underestimation of the odds ratios, but
 5 approximately equal because of the rareness of the
 6 disease.
 7 Q (BY MR. ZELLERS) So she adopted, at your
 8 suggestion, the option that she states,
 9 understanding that relative risk may considerably
 10 underestimate odds ratios; is that right?
 11 A Yes, it is.
 12 Q And you advised her -- for No. 3, how did
 13 you advise her when she told you that she was unable
 14 to calculate the true -- or truly estimate for any
 15 talc use and suggested that you consider pooling the
 16 results from rarely, monthly, weekly, and daily?
 17 MS. O'DELL: Object to the form. Are you
 18 talking about No. 3? It's not clear.
 19 A So the option that we did for that choice
 20 is actually neither Option 1 or Option 2.
 21 The focus of the review that she completed
 22 was, in fact, on daily talc use. It's not different
 23 than she suggested.
 24 But she used the numbers that were
 25 incorrectly categorized as any talc use instead to

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1 represent daily talc use, so that -- that data point
 2 was moved for the daily talc use category.
 3 Q Let me show you the Chang paper. This is
 4 one of the papers that you cite both in Figure 2 and
 5 again on Figure 3; is that right?
 6 A Yes.
 7 Q All right. Here's the Chang paper which
 8 we have marked as Exhibit 25.
 9 A Oh.
 10 (Exhibit 25 was marked for identification
 11 and is attached to the transcript.)
 12 Q (BY MR. ZELLERS) Do you have that in front
 13 of you?
 14 A I do.
 15 Q Okay. Show us -- you see in Figure 2,
 16 that Chang is listed twice, and it has a confidence
 17 interval of .51 to 1.39.
 18 Do you see that?
 19 A You said it's listed twice?
 20 Q I'm sorry. It was -- it's listed in
 21 Figure 2 and then you list it again in Figure 3; is
 22 that right?
 23 A Yes.
 24 Q All right. The first question is: Where
 25 in the Chang publication do you get a confidence

<p style="text-align: right;">Page 190</p> <p>1 interval of .51 to 1.39?</p> <p>2 A Hum? So the point estimate that I</p> <p>3 think -- I need to look at the paper a little more</p> <p>4 closely.</p> <p>5 So the number I see in this paper is</p> <p>6 instead of being .51 to 1.39 is .61 to 1.49 is about</p> <p>7 ten points higher.</p> <p>8 Q All right. You don't know where, for</p> <p>9 Figure 2, the confidence interval of .51 to 1.39</p> <p>10 came from, correct?</p> <p>11 A I -- I do not. It's so close to the</p> <p>12 publication -- the publication that I'm not sure if</p> <p>13 it reflects a data abstraction error or if it was --</p> <p>14 I think that's probably what it -- what it does, but</p> <p>15 I'm not sure.</p> <p>16 Q The Chang paper involved 450 patients with</p> <p>17 borderline and invasive ovarian carcinoma; is that</p> <p>18 right?</p> <p>19 A Say it one more time for me.</p> <p>20 Q Sure. The Chang paper --</p> <p>21 A Yeah.</p> <p>22 Q -- Exhibit 25, involved a total of</p> <p>23 450 patients with borderline and invasive ovarian</p> <p>24 carcinoma; is that right?</p> <p>25 A Yes.</p>	<p style="text-align: right;">Page 192</p> <p>1 notes here, but I believe what I did for Chang is</p> <p>2 that Chang's numbers are included in the Terry</p> <p>3 report where she used the data that were published,</p> <p>4 as well as the supplemental data that were provided</p> <p>5 by Chang.</p> <p>6 And within the supplemental data, Terry</p> <p>7 did a stratified analysis that provided additional</p> <p>8 information on serous cancer that was not actually</p> <p>9 in the original Chang report.</p> <p>10 And those are the data that made it into</p> <p>11 what is under Chang in this systematic review.</p> <p>12 Q (BY MR. ZELLERS) Okay.</p> <p>13 A So they're data from Chang's work and</p> <p>14 following Chang's methods. They happen not to be</p> <p>15 published in Chang's original report, but rather</p> <p>16 included in the Terry report from -- from 2013.</p> <p>17 And Terry -- the paper that I am talking</p> <p>18 about for Terry is genital powder use and risk of</p> <p>19 ovarian cancer, a pooled analysis of 8,500 cases and</p> <p>20 ninety-eight hundred fifty-nine controls.</p> <p>21 And then within that describes within the</p> <p>22 methods, getting extra data for studies describing</p> <p>23 the regular use and then breaking down the results</p> <p>24 into whether or not it was invasive borderline,</p> <p>25 invasive serous, and so forth --</p>
<p style="text-align: right;">Page 191</p> <p>1 Q You used or Dr. Hall used, in your</p> <p>2 analysis, only 41 of those 450 patients because</p> <p>3 those are the only ones that had greater than</p> <p>4 25 times of use per month, correct?</p> <p>5 A So I would need to look at my datasheet to</p> <p>6 know how many made it into the analysis, but I</p> <p>7 believe you're correct, that there were</p> <p>8 approximately 10 percent that were frequent users.</p> <p>9 Q How did you determine, just looking at the</p> <p>10 Chang paper, how many of those 41 had invasive</p> <p>11 serous ovarian cancer?</p> <p>12 MS. O'DELL: If you need to look at your</p> <p>13 datasheets --</p> <p>14 A Please.</p> <p>15 MS. O'DELL: Which --</p> <p>16 A That would be great.</p> <p>17 MS. O'DELL: -- which data -- tell -- data</p> <p>18 summary, is that what --</p> <p>19 A Yeah --</p> <p>20 MS. O'DELL: -- you are --</p> <p>21 A -- that should be it.</p> <p>22 MS. O'DELL: Okay. This is both --</p> <p>23 both -- both of the spreadsheets are there, so just</p> <p>24 --</p> <p>25 A Okay. So I don't have all of my detailed</p>	<p style="text-align: right;">Page 193</p> <p>1 Q So --</p> <p>2 A -- so that's where those numbers came</p> <p>3 from.</p> <p>4 Q You believe that if I looked at the Terry</p> <p>5 paper, I would be able to tell of these 41 cases</p> <p>6 that have greater than 25 uses per month, which of</p> <p>7 those cases involved invasive serous ovarian cancer,</p> <p>8 correct?</p> <p>9 MS. O'DELL: Object to the form.</p> <p>10 A I believe the -- I believe the number of</p> <p>11 cases is specified in the Terry paper that I would</p> <p>12 have to look at to find that -- that number.</p> <p>13 Q (BY MR. ZELLERS) All right. Let me ask</p> <p>14 you a few questions.</p> <p>15 A Yes.</p> <p>16 Q In the Chang paper --</p> <p>17 A Yes.</p> <p>18 Q -- the authors do not define "regular use"</p> <p>19 as daily, do they?</p> <p>20 A What Chang says in the original</p> <p>21 publication is questions about regular talc use and</p> <p>22 type of talc use, as well as duration and frequency</p> <p>23 could be derived or included; dusting or powdering</p> <p>24 behavior considered improved regular application of</p> <p>25 talc to the perineum after showering or bathing and</p>

<p style="text-align: right;">Page 194</p> <p>1 dusting.</p> <p>2 And then that was categorized, I believe</p> <p>3 by Terry, as regular use when she got supplemental</p> <p>4 data.</p> <p>5 Q Okay. In the Chang paper, the authors do</p> <p>6 not define "regular use" as daily use, correct?</p> <p>7 MS. O'DELL: Object to the form; asked and</p> <p>8 answered.</p> <p>9 A The Chang paper explicitly says "regular</p> <p>10 use." In the original publication, they don't</p> <p>11 define it.</p> <p>12 Q (BY MR. ZELLERS) They do not include</p> <p>13 information in the Chang paper about how many times</p> <p>14 per week women used talcum powder, correct?</p> <p>15 MS. O'DELL: Object to the form.</p> <p>16 A In -- in Table 2 of Chang, they define it</p> <p>17 as less than ten, ten to 25, or greater than 25</p> <p>18 times per week.</p> <p>19 Q (BY MR. ZELLERS) Where do you see that?</p> <p>20 A In Chang?</p> <p>21 Q Yes. I'm looking at the same table, and I</p> <p>22 think it's per month.</p> <p>23 A Per month.</p> <p>24 Q Okay. And that's the only data that's</p> <p>25 provided with respect to use is the number of</p>	<p style="text-align: right;">Page 196</p> <p>1 of invasive besides just serous.</p> <p>2 Q Do you know that?</p> <p>3 A I -- I don't think they specify what's</p> <p>4 included in that. I have to add up the total to see</p> <p>5 if they are overlapping or not overlapping.</p> <p>6 Could you add -- could you add that for</p> <p>7 me? Actually, the total should be -- they're</p> <p>8 overlapping. 360, 460. Yeah, they're overlapping.</p> <p>9 Yeah.</p> <p>10 Q What do you mean, "they're overlapping"?</p> <p>11 A Invasive and borderline should add up to</p> <p>12 the total.</p> <p>13 And then serous mucin -- mucinous and</p> <p>14 endometrioid should add up to the total, except to</p> <p>15 the degree that they are missing information.</p> <p>16 Q Looking at the questions that Dr. Hall</p> <p>17 asked you --</p> <p>18 A Yes.</p> <p>19 Q -- in Exhibit 24, you would agree that</p> <p>20 there were number of assumptions that you and she</p> <p>21 made in order to complete your systematic review; is</p> <p>22 that right?</p> <p>23 A Absolutely.</p> <p>24 Q Is there anywhere that you have written</p> <p>25 down, you know, what the assumptions were that you</p>
<p style="text-align: right;">Page 195</p> <p>1 monthly applications, correct?</p> <p>2 A Yes.</p> <p>3 Q The authors of Chang did not arrive at a</p> <p>4 specific odds ratio for serous invasive cancer based</p> <p>5 on frequency of use, correct?</p> <p>6 A The Chang data was used by Terry to</p> <p>7 calculate frequency of use for serous and invasive</p> <p>8 by supplementing the original data that they had</p> <p>9 from additional data from Chang as a participant in</p> <p>10 the OCAC consortium.</p> <p>11 So additional data from that study was</p> <p>12 shared with Terry, which is what we used in our</p> <p>13 analysis.</p> <p>14 Q If we look at Chang in Table 3, they</p> <p>15 describe a histologic type of invasive; is that</p> <p>16 right, in Table 3, page 2399?</p> <p>17 A Yes.</p> <p>18 Q They also describe serous; is that right?</p> <p>19 A Yes.</p> <p>20 Q In the Chang data, what's the difference</p> <p>21 between invasive and serous?</p> <p>22 A I'm -- I'm sorry. In lot -- in Table 3</p> <p>23 you're asking what those different entries mean?</p> <p>24 Q Yes.</p> <p>25 A "Invasive" presumably includes other types</p>	<p style="text-align: right;">Page 197</p> <p>1 and Dr. Hall arrived at, at least in part in</p> <p>2 response to her questions?</p> <p>3 A So for some of the issues, it took me</p> <p>4 quite a bit of remembering to remember that we used</p> <p>5 some of the extracted data from more than one</p> <p>6 source.</p> <p>7 We have notes in our data form of what the</p> <p>8 source of the data was, so it would say in some of</p> <p>9 the data I said -- under Chang, it would say "in a</p> <p>10 column from Terry."</p> <p>11 Q My question --</p> <p>12 A So that -- that -- so to answer the</p> <p>13 assumption of where the data came from, it's in my</p> <p>14 data spreadsheet. I just -- I just didn't remember</p> <p>15 that we pulled data.</p> <p>16 Q My -- my question is a little different I</p> <p>17 --</p> <p>18 A Okay.</p> <p>19 Q -- think. In terms of all of the</p> <p>20 questions that Dr. Hall asked you and all of the</p> <p>21 assumptions that would need to be made so that</p> <p>22 estimates could be arrived at, do you have either</p> <p>23 your protocol or a listing of the assumptions that</p> <p>24 were made by you and by Dr. Hall in -- at least in</p> <p>25 part in response to the question she raised?</p>

<p style="text-align: right;">Page 198</p> <p>1 MS. O'DELL: Objection, asked and 2 answered. Respond. 3 A I am under the impression that they're 4 documented within our e-mail exchanges, but I do not 5 have a protocol with each of these decisions that 6 are laid out. 7 Q (BY MR. ZELLERS) I -- my best source would 8 be the e-mail exchanges that you had with Dr. Hall, 9 correct? 10 MS. O'DELL: Object to the form. 11 Q (BY MR. ZELLERS) Is that right? 12 A Yes. 13 Q Okay. Once you did your ten studies that 14 are in Figure 2 -- and those were just the -- 15 the studies that you chose to include, as you have 16 told us, showing odds of ovarian cancer associated 17 with regular use of talcum powder -- you further 18 refined the studies or narrowed down the studies to 19 four which you state plot or who the odds of ovarian 20 cancer associated with regular use of talcum powder 21 and invasive serous cancer; is that right? 22 MS. O'DELL: Object to the form. 23 A With the caveat that when -- when I laid 24 out our stratified analysis on page 32, it says, My 25 review focused on invasive serous cancer where</p>	<p style="text-align: right;">Page 200</p> <p>1 confidence interval for the -- let's say the Chang 2 data that you list in Figure 3? 3 A I'm going to have to look into the exact 4 calculation of the confidence interval. 5 The question that you asked me about Chang 6 for the first table is very close to the one that's 7 published -- so close -- that I'm not sure how it 8 would be different. 9 I don't -- I thought these were abstracted 10 from the paper. And I would have to go back and 11 talk to Dr. Hall about how they were calculated. 12 I thought they were calculated, but I -- I 13 may be -- I may be wrong. They may have been in 14 some way reestimated. 15 So again, similar with this, these numbers 16 are close to the ones that are in this paper, but 17 are slightly off, and I'm not sure why. 18 So I would have to go back to the data 19 that I abstracted and then the data that she sent me 20 back for the final tables to see why they were 21 different. 22 Q Okay. 23 A But they're -- they're different to a -- 24 such a slight degree that -- and I'm not really sure 25 where that difference came from.</p>
<p style="text-align: right;">Page 199</p> <p>1 possible, but also included all invasive cancer. 2 Q (BY MR. ZELLERS) What did you do to get 3 from the ten studies that you list in Figure 2 to 4 the four studies that you list in Figure 3? 5 A Figure 2 is ovarian cancer with regular 6 use, and Figure 3 is invasive serous cancer. 7 If there was not invasive serous but there 8 was just invasive, they also might be in this. I 9 would have to review these four studies to know if 10 it was invasive or invasive serous. 11 Q Do you know, as you sit here, what you did 12 to go from the ten studies in Figure 2 to the four 13 studies in Figure 3? 14 MS. O'DELL: Object to the form. 15 A In the data set that I sent to you and 16 sent to Dr. Hall, they would -- there were different 17 sets of complete data. And the Figure 3 had data 18 for invasive or invasive serous cancer; whereas, 19 Figure 2 had -- included invasive and noninvasive. 20 So it would just be where there were data 21 available in the data worksheet. I -- I was not 22 involved in making the selection to go from one to 23 the other. It was just where there were data that 24 were abstracted from the papers. 25 Q (BY MR. ZELLERS) Where did you get the</p>	<p style="text-align: right;">Page 201</p> <p>1 Q Were there any other analyses that you or 2 Dr. Hall con -- conducted that are not included in 3 your report? 4 A I had asked Dr. Hall, I believe, to look 5 at -- at several analyses that are all in the data 6 that I shared with you. 7 The sensitivity analysis for Terry and the 8 sensitivity analysis for the Rosen [sic] study are 9 in the data I sent you, but are not summarized in 10 the report. 11 MS. O'DELL: And by "the data," you're 12 talking about the spreadsheets -- 13 A Yes. 14 MS. O'DELL: -- that you provided? 15 A Yes. There -- there are more analyses 16 that were done that you haven't seen. But they -- 17 they were analysis for four analyses. 18 I just see two here. So I -- there were 19 two others. I think it was including Terry and 20 including Rosenblatt, I think, are the other two. 21 But you have all of the -- there were no 22 other analyses except those four that she completed. 23 MS. O'DELL: Excuse me, Mike. I'm sorry. 24 We're right at 3:00 p.m. When you get to a stopping 25 point, can we take a break?</p>

<p style="text-align: right;">Page 202</p> <p>1 MR. ZELLERS: All right. Let's stop. 2 We're stopping for the day; is that right? 3 MS. O'DELL: Let's -- let me speak with 4 Dr. Smith-Bindman on the break and then I'll let you 5 know. 6 MR. ZELLERS: All right. 7 THE VIDEOGRAPHER: We're off the record at 8 2:59 p.m. 9 (A break was taken from 2:59 p.m. to 10 3:11 p.m.) 11 THE VIDEOGRAPHER: We are back on the 12 record. This marks the beginning of Disc No. 4 in 13 the deposition of Dr. Rebecca Smith-Bindman. The 14 time is 3:11 p.m. 15 Q (BY MR. ZELLERS) Dr. Smith-Bindman, what 16 methodology, if anything different, did you use to 17 arrive at your opinion that there was a causal 18 association between genital talcum powder use and 19 ovarian cancer? 20 A I used the Bradford Hill criteria. 21 Q Are you familiar with the Bradford Hill 22 criteria? 23 A I am. Yes, I am. 24 Q You're familiar that over time the FDA has 25 gone through and done various analyses with respect</p>	<p style="text-align: right;">Page 204</p> <p>1 Q The FDA, in 2014, reviewed the 2 epidemiology and etiology findings relating to 3 ovarian cancer and the genital application of talc; 4 is that right? 5 MS. O'DELL: Object to the form. 6 A Yes. 7 Q (BY MR. ZELLERS) The FDA noted that 8 selection bias and/or uncontrolled confounding 9 result in spurious positive associations between 10 talc use and ovarian cancer; is that right? 11 MS. O'DELL: Object to the form. 12 A The FDA concluded that some of the studies 13 had biases. Yes, they did. 14 Q (BY MR. ZELLERS) And if we look at No. 2, 15 the FDA states, No single study has considered all 16 the factors that potentially contribute to ovarian 17 cancer, including selection biased and/or 18 uncontrolled confounding that result in spurious 19 positive associations between talc use and ovarian 20 cancer risk. 21 Is that right? 22 A That is what the FDA concluded. 23 Q The FDA also noted that there was a lack 24 of consistency in the study results; is that right? 25 A That is what the FDA concluded.</p>
<p style="text-align: right;">Page 203</p> <p>1 to perineal talcum powder use and any association 2 with ovarian cancer; is that right? 3 MS. O'DELL: Object to the form. 4 A I -- I have seen some documents by the 5 FDA. 6 Q (BY MR. ZELLERS) And the FDA, back in 7 2014, did a review and analysis of the epidemiology 8 at that time; is that right? 9 MS. O'DELL: Object to the form. 10 A Could you show me that document? 11 Q (BY MR. ZELLERS) Sure. This is a document 12 that we'll mark as Exhibit 26. 13 (Exhibit 26 was marked for identification 14 and is attached to the transcript.) 15 Q (BY MR. ZELLERS) It's a document from the 16 FDA. It's got a date stamp at the top -- 17 MS. O'DELL: Thank you. 18 Q (BY MR. ZELLERS) -- April 1 of 2014. 19 Is this one of the documents that you have 20 reviewed in connection with your expert work in this 21 matter? 22 A Yes, it is. 23 Q Turn, if you will, to page 4 of that 24 document. Do you see that? 25 A Yes.</p>	<p style="text-align: right;">Page 205</p> <p>1 Q And specifically the FDA concludes, 2 Results of case-control studies do not demonstrate a 3 consistent, positive association across studies; is 4 that right? 5 MS. O'DELL: I think it says something 6 further than that. 7 A Can I just add something? This -- the FDA 8 did some review that I don't know the details of. 9 And this is their summary of that review, which I 10 don't know the details of, yes. 11 Q (BY MR. ZELLERS) The FDA, at least in this 12 review, stated that dose response evidence is 13 lacking; is that right? 14 And I am looking at the end of Point No. 3 15 on page 4. 16 A That is what the FDA concluded. 17 Q And looking at Point No. 4, the FDA found 18 that a cogent biological mechanism was lacking; is 19 that right? 20 A That is what the FDA concluded. 21 Q You have reviewed IARC; is that right? 22 And I think in your blue folder here you have 23 included some IARC documents? 24 A I have included IARC work reflecting 25 analysis through 2006 and then more recently</p>

<p style="text-align: right;">Page 206</p> <p>1 through -- through 2010, each published a few years 2 after that.</p> <p>3 Q IARC has gone through and addressed the 4 Bradford Hill considerations with respect to the 5 classification of genital talc; is that right?</p> <p>6 MS. O'DELL: Object to the form.</p> <p>7 A Can you remind me which analysis you're 8 referring to?</p> <p>9 Q (BY MR. ZELLERS) Well, let's start with 10 the classifications. Take a look at Exhibit 27, if 11 you will.</p> <p>12 (Exhibit 27 was marked for identification 13 and is attached to the transcript.)</p> <p>14 Q (BY MR. ZELLERS) Are these the IARC 15 classifications for its determination --</p> <p>16 MS. O'DELL: Thank you.</p> <p>17 Q (BY MR. ZELLERS) -- as to the 18 carcinogenicity -- carcinogenicity of different 19 agents?</p> <p>20 A Yes.</p> <p>21 Q And you're generally familiar with these 22 classifications; is that right?</p> <p>23 A I am.</p> <p>24 Q Group 1, these are the agents that IARC 25 has determined are carcinogenic to humans, correct?</p>	<p style="text-align: right;">Page 208</p> <p>1 prove that something is safe is -- is next to 2 impossible --</p> <p>3 Q (BY MR. ZELLERS) Right.</p> <p>4 A -- and so that's why that category is 5 not -- is used. Category 3 and four can, for the 6 sake of discussion, be considered the same.</p> <p>7 Q And that's why there's no Group 5, not 8 carcinogenic; is that right?</p> <p>9 A Yes.</p> <p>10 Q Correct? Now, with genital talc, IARC has 11 determined that it is appropriately placed in the 12 "to be" category; is that right?</p> <p>13 MS. O'DELL: Object to the form.</p> <p>14 A I -- I would take a slight pause to that 15 consideration. I think that in the first review 16 when they have looked at platy talc, they consider 17 it a "to be" possibly carcinogenic to humans.</p> <p>18 Whereas, in the report looking at asbestos 19 and fibrous talc, which also counts in the same 20 category as asbestos, the -- that is in the category 21 that's a Group 1 carcinogenic to humans.</p> <p>22 Q (BY MR. ZELLERS) IARC has determined that 23 genital talc is a group to be possibly carcinogenic 24 to humans; is that right?</p> <p>25 MS. O'DELL: Object to the form.</p>
<p style="text-align: right;">Page 207</p> <p>1 A Yes.</p> <p>2 Q And that's the only category in which IARC 3 finds sufficient evidence in humans; is that right?</p> <p>4 MS. O'DELL: Object to the form.</p> <p>5 A That's how they define that category.</p> <p>6 Q (BY MR. ZELLERS) IARC puts 82 agents in 7 Group 2A probably carcinogenic to humans; is that 8 right?</p> <p>9 A That is correct.</p> <p>10 Q So IARC has gone through and has evaluated 11 many, many, many agents and has determined that 12 there are over 200 agents in both the Group 1 13 category and also the Group 2A category, correct?</p> <p>14 A Yes.</p> <p>15 Q There's only one agent in Group 4, 16 probably not carcinogenic to humans; is that right?</p> <p>17 MS. O'DELL: Object to the form.</p> <p>18 A Yes, that's correct.</p> <p>19 Q (BY MR. ZELLERS) So out of the over a 20 thousand agents that IARC has reviewed, it's only 21 placed one agent in Group 4 probably not 22 carcinogenic; is that right?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A To be considered by IARC, there has to be 25 data to suggest there's some potential harm. And to</p>	<p style="text-align: right;">Page 209</p> <p>1 Misstates her testimony.</p> <p>2 A So in their initial review -- in their 3 earlier review, they concluded that genital talc is 4 possibly carcinogenic to humans.</p> <p>5 In the more recent 2012, they discuss that 6 cosmetics are the primary sources of exposure to 7 talc in the general population; that perineal 8 application is the primary route and that fibrous 9 talc, which is part of talc, is actually Group 1 10 carcinogenic.</p> <p>11 Q (BY MR. ZELLERS) All right. Show me the 12 IARC designation of genital talc as a Group 1 13 carcinogenic.</p> <p>14 MS. O'DELL: Object to the form.</p> <p>15 A Genital talc contains platy talc, as well 16 as fibrous talc, as well as asbestiform contaminated 17 talc, and they consider any fibrous talc to be a 18 Group 1 carcinogen.</p> <p>19 Q (BY MR. ZELLERS) Show me where the 20 perineal application of genital talc has been 21 determined by IARC to be a Group 1 carcinogen.</p> <p>22 MS. O'DELL: Object to the form. Would 23 you like to see the IARC?</p> <p>24 A Can you show me the IARC report?</p> <p>25 Q (BY MR. ZELLERS) No. I would like you --</p>

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1 you're the one who is testifying.
 2 A I just don't have the document in front of
 3 me. How would you like me to show it to you?
 4 Q I -- I would like you to show me where
 5 genital talc has been found by IARC to be a Group 1
 6 carcinogen.
 7 MS. O'DELL: Object to the form. So was
 8 that not -- excuse me, Doctor. Is that not
 9 something you're going to put in front of her?
 10 Q (BY MR. ZELLERS) I -- I have my
 11 information. And my IARC review says that they have
 12 classified genital talc as a group to be possibly
 13 carcinogenic to humans.
 14 A Do you have the 2012 --
 15 MS. O'DELL: Yes. Let me just get it for
 16 you, Doctor. Give me a moment to see what number it
 17 is in your references.
 18 Q (BY MR. ZELLERS) As your counsel is
 19 looking for that document, can we agree that the "to
 20 be" designation with IARC is based on limited
 21 evidence in humans, which means IARC cannot rule out
 22 chance, bias, or confounding with reasonable
 23 confidence?
 24 A In their original assessment of talc in
 25 2010 where they classified it as to be, the "to be"

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1 designation means that it's possibly carcinogenic,
 2 which is a very high bar for them to put them in
 3 that category, but could also be due to chance.
 4 Q Okay. Also, in class "to be" as possibly
 5 carcinogenic is ginkgo biloba; is that right?
 6 A I -- I have no idea.
 7 Q Occupational carpentry and joinery; is
 8 that right?
 9 A I -- I -- I have no idea.
 10 Q Pickled --
 11 A I --
 12 Q -- vegetables?
 13 A -- I think pickled vegetables are pretty
 14 carcinogenic, but I -- I don't know what IARC thinks
 15 of them.
 16 Q Do you believe that the standard for
 17 prove -- proving causation in the scientific
 18 literature is the same as the one that applies in
 19 litigation?
 20 A Yes, I do.
 21 Q Do you want to show me what your counsel
 22 has provided you?
 23 A Yes.
 24 Q And I am looking for the finding that IARC
 25 that genital talc use is a Group 1 carcinogen.

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1 A So this is the monograph -- the
 2 monograph -- the IARC monograph on the evaluation of
 3 carcinogenic risks -- arsenic metals, fibrous and
 4 dust, volume 100C. So --
 5 Q I'm looking for perineal talc.
 6 A No. No. I know. I understand.
 7 Q Okay.
 8 A I'm just telling you where I'm -- I'm
 9 going to be pulling this from. And I'm looking at
 10 the section under "Asbestos." And under the Pier --
 11 the -- the section under "Asbestos, it talks, under
 12 1.C --
 13 Q What page?
 14 A -- 230. And I will read several sections
 15 of it. This section says, Talc particles are
 16 normally plate-like. These particles are viewed on
 17 edge under the microscope.
 18 THE COURT REPORTER: I have to have you
 19 slow down when you read.
 20 A I'm so sorry. May appear to be fibers.
 21 Talc may also form true mineral fibers that are
 22 asbestiform in habit.
 23 In some talc deposits, tremolite,
 24 anthophyllite, and actinolite may occur. Talc
 25 containing asbestiform fibers is a term that has

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1 been used inconsistently.
 2 I'm -- I'm just seeing where the --
 3 Q (BY MR. ZELLERS) That's okay. And I am
 4 looking for the statement or the finding that
 5 genital talc -- cosmetic genital talc has been
 6 determined by IARC to be a Group 1 carcinogen.
 7 A So I'm in the section --
 8 MS. O'DELL: Object to the form.
 9 A -- on the talc and asbestiform talc. And
 10 under 1.65, "Human Exposure," under "A," it says,
 11 Exposure of the general population: Consumer
 12 products, cosmetics, pharmaceuticals are the primary
 13 source of exposure to talc for the general
 14 population. Inhalation and dermal contact through
 15 perineal application are the primary routes of
 16 exposure.
 17 Q (BY MR. ZELLERS) Where does IARC conclude
 18 that perineal talc use, cosmetic talc, is a Group 1
 19 carcinogen?
 20 MS. O'DELL: Object to the form.
 21 A As late as 1973, talc products contained
 22 detectable levels of chrysotile asbestos, tremolite,
 23 or anthophyllite role. And it's possible they
 24 remained on the market in some places for some time
 25 after that. And these are asbestiform in habit.

<p style="text-align: right;">Page 214</p> <p>1 It goes on to cite a whole lot of other 2 places, Blount and so forth. 3 And then in this same document they 4 categorize the asbestos and asbestiform fibers as 5 being a Group 1 carcinogen. 6 Q (BY MR. ZELLERS) I'm going to ask you 7 about asbestos and I'm going to ask you about 8 asbestiform fibers. 9 What I want to know is: Where does IARC, 10 in the publication you're looking at, categorize 11 cosmetic talc applied perineal -- to the perineal 12 region as a Group 1 carcinogen? 13 MS. O'DELL: Object to the form. 14 A They're telling us in this document that 15 asbestos and asbestiform talc are Group 1 16 carcinogens. 17 They're telling us at the cite -- the -- 18 the most common exposure is consumer products. And 19 inhalation and dermal contact with perineal 20 application of talc powders are the primary routes 21 of exposure. 22 Q (BY MR. ZELLERS) Where does IARC state 23 that perineal use of cosmetic talc is a Group 1 24 carcinogen? 25 MS. O'DELL: Object to the form.</p>	<p style="text-align: right;">Page 216</p> <p>1 MS. O'DELL: As I'm not coaching the 2 witness. So you can ask the questions, but you 3 can't raise your voice and -- and continue -- 4 MR. ZELLERS: We have a video record. 5 MS. O'DELL: -- yes, we do. 6 MR. ZELLERS: No one here would say that 7 I'm raising my voice to the witness or behaving in 8 any way other than professionally. 9 A I'm looking for the executive summary. 10 It's just taking a while in this very large document 11 to -- I see the problem. 12 The copy of this document, I'm missing my 13 first few pages. 14 Q (BY MR. ZELLERS) Okay. 15 A It starts at 30 -- 31. 16 THE COURT REPORTER: Did you say "few" or 17 "first three"? 18 A I think I'm missing the first 30 pages. 19 Q (BY MR. ZELLERS) All right. Let -- 20 A So -- 21 Q -- me move on then. 22 A -- okay. 23 Q Strength of association is a Bradford Hill 24 criteria -- is that -- criterion; is that right? 25 A Yes, it is.</p>
<p style="text-align: right;">Page 215</p> <p>1 A So IARC is telling us which compounds are 2 Group 1 carcinogens. 3 Q (BY MR. ZELLERS) Where does it state that 4 the perineal use of cosmetic talc is a Group 1 5 carcinogen? 6 MS. O'DELL: Object to the form. She has 7 already stated that three times. 8 MR. ZELLERS: Well, I haven't heard it 9 yet -- 10 MS. O'DELL: Yes. 11 MR. ZELLERS: -- Counsel. 12 MS. O'DELL: Yes, you -- she has described 13 it to you three times or four times maybe. And so 14 she has -- 15 MR. ZELLERS: Counsel -- 16 MS. O'DELL: -- answered your question. 17 MR. ZELLERS: -- please don't coach the 18 witness. Just -- 19 MS. O'DELL: -- I'm not -- I'm not -- 20 MR. ZELLERS: -- object to form, if you 21 want to object to form. 22 MS. O'DELL: -- well, don't harass the 23 witness, which -- that's what I am -- 24 MR. ZELLERS: I'm not harassing the 25 witness.</p>	<p style="text-align: right;">Page 217</p> <p>1 Q You -- one of the studies you reviewed was 2 Langseth; is that right? 3 A Yes, it is. 4 Q Langseth reviewed the overall pooled odds 5 of cancer and found that there was an odds ratio of 6 1.35 across the studies; is that right? 7 A I'm going to look for it, but -- 8 Q Okay. I -- 9 A -- it sounds about right. 10 Q -- I will hand you Langseth. 11 A I have it. 12 Q If you take a look at page 359, 13 Figure 1 -- do you see that -- do you know Langseth? 14 A I do. 15 Q Langseth looks at the case-control 16 studies, both the population-based and the 17 hospital-based; is that right? 18 A He looked at the studies that had a -- he 19 had available when this was established a decade 20 ago, yes. 21 Q And -- and he lists out 20 case-control 22 studies, correct? 23 A 14? 24 Q I'm looking at the chart above Figure 1. 25 And you think there's only 14 studies there?</p>

<p style="text-align: right;">Page 218</p> <p>1 A Oh, I apologize. I thought you were 2 talking about the population-based studies. 3 No. You're absolutely right. 20 studies. 4 Q And of those 20 studies, only ten have 5 statistical significance; is that right? 6 A The original studies with the sample size 7 they had, ten seemed to have difference than one. 8 Q Of the 20 studies -- the 20 case-control 9 studies that were available and were studied by 10 Langseth, only ten had statistically significant 11 results; is that right? 12 MS. O'DELL: Object to the form. 13 A Again, he is combining them together. But 14 in the original form when they were not combined, 15 there are ten in their original form that had 16 statistical differences than one. They could 17 exclude one. 18 Q (BY MR. ZELLERS) Half of the studies did 19 not have statistically significant results; is that 20 right? 21 A The original studies had wide confidence 22 intervals. And the original studies, before they 23 were combined, many of them overlapped one. 24 Q Is the answer yes to my question? 25 MS. O'DELL: She has answered your</p>	<p style="text-align: right;">Page 220</p> <p>1 a causal association between perineal use of talc 2 and ovarian cancer? 3 MS. O'DELL: Objection to form. 4 A The Langseth study is one review. And as 5 I describe in my report, it seems like a well-done 6 review, although it does not provide the kind of 7 details that I would hope it would provide given 8 sort of the stature of some of the people who were 9 involved in writing the report. 10 That being said, this systematic review 11 suggests that there's an association between 12 perineal talc exposure and ovarian cancer. 13 Q You -- 14 A By itself, I don't think it provides 15 enough data to have causality, but it provides good 16 evidence that there's an association. 17 Q You understand that your interpretation of 18 this study is different and broader than the 19 authors' interpretation of the data, correct? 20 MS. O'DELL: Object to the form. 21 A One of the author's conclusion that I 22 found quite compelling was in -- on page 358 in the 23 second paragraph -- in the second column -- 24 Q (BY MR. ZELLERS) Can you answer my 25 question?</p>
<p style="text-align: right;">Page 219</p> <p>1 question. 2 MR. ZELLERS: Well, I -- I don't know. I 3 haven't heard an answer. 4 MS. O'DELL: You have heard a complete 5 answer. 6 A You're asking me to look at the results in 7 Figure 1 -- 8 Q (BY MR. ZELLERS) Yes. 9 A -- which are meant to combine results. 10 But they also had the individual original study 11 sample size and show that about half of them overlap 12 one. 13 Q Half is no better than a coin toss, 14 correct? 15 MS. O'DELL: Object to the form. 16 A It's an interesting question. But if 17 you're looking for something, is there an 18 association with an exposure with cancer, a random 19 selection of that, you would expect to find very few 20 positive associations. 21 To find half is an enormous association to 22 find from random studies if there was no 23 association. 24 Q (BY MR. ZELLERS) Do you believe that based 25 upon the Langseth paper and analysis, that there is</p>	<p style="text-align: right;">Page 221</p> <p>1 MS. O'DELL: She has answered your 2 question. Don't -- 3 MR. ZELLERS: Well, I don't think she is 4 answering my question. 5 A I think you are asking me about what the 6 authors conclude. 7 Q (BY MR. ZELLERS) I asked if your 8 conclusion was broader than the authors' -- 9 MS. O'DELL: And she is telling you what 10 the authors' conclusions are. You may finish, 11 Doctor. 12 A What -- what Langseth says is that, Eight 13 of the population-based case-control studies were 14 identified by the Arforthinger (phonetic) as being 15 the most informative in terms of the size of the 16 studies, whether the studies were population-based 17 participation rates and adjustment for confounding 18 variables. These selected studies -- among these 19 eight studies, the prevalence of use of talc was 16 20 to -- 21 THE COURT REPORTER: I can't hear. 22 A -- sorry. The selected studies included 23 at least 188 cases and had participation rates 24 ranging up to 75 percent. Among these eight 25 studies, the prevalence of peritoneal use of</p>

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1 talc-based body powder among controls ranged from 16
 2 to 52 percent.
 3 The relative risk of ovarian cancer among
 4 body powder users were homogeneous across the set of
 5 eight studies, each of which indicated a 30 to
 6 60 percent increase in risk.
 7 Among the other 12 case-control studies,
 8 most also reported relative risk of this magnitude
 9 or higher.
 10 So I think the authors of this concluded
 11 that the better studies showed a very strong
 12 association. And -- and I -- I'm not sure what
 13 conclusion of the authors you're asking me to
 14 disagree with.
 15 Q (BY MR. ZELLERS) Okay. Doctor, take a
 16 look at "Proposal to Research Community" on the
 17 right-hand side of page 359.
 18 Do you see that?
 19 A I do.
 20 Q I'm going to read this, and you tell me if
 21 I read it correctly.
 22 "The current body of experimental and
 23 epidemiological evidence is insufficient to
 24 establish a causal association between perineal use
 25 of talc and ovarian cancer risk.

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1 Experimental research is needed to better
 2 characterize deposition, retention, and clearance of
 3 talc to evaluate the ovarian carcinogenicity of
 4 talc."
 5 Did I read that correctly?
 6 A Not only did you read that correctly, I
 7 would agree with that based on data available in
 8 2008.
 9 So you asked me if I thought this study by
 10 itself evaluated causality.
 11 And this study did not discuss the
 12 deposition, the retention, or clearance. And I
 13 think those factors are crucial to understanding the
 14 causality.
 15 Q Okay.
 16 A And that's new since --
 17 MR. ZELLERS: Move --
 18 A -- 2008.
 19 MR. ZELLERS: -- to strike as not --
 20 MS. O'DELL: She is --
 21 MR. ZELLERS: -- she finished.
 22 MS. O'DELL: -- she did not finish.
 23 MR. ZELLERS: Did you finish?
 24 A I was close enough.
 25 MR. ZELLERS: All right. Move to strike

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1 as nonresponsive.
 2 My question was: Did I read that
 3 correctly?
 4 A You read that text correctly.
 5 Q All right. You conclude in your report
 6 with respect to strength of association that because
 7 a very large number of ovarian cancers are caused by
 8 talcum powder and talcum powder provides no
 9 better -- no medical benefit, the Hill criterion of
 10 strength of association is important and met.
 11 Is that right?
 12 A I don't think that's exactly right. I --
 13 I think all of the things I believe are in there
 14 somewhere, but that's not quite what I would be --
 15 Q I --
 16 A -- report.
 17 Q -- I'm just reading from page 38 of your
 18 report. Do you believe that because a very large
 19 number of ovarian cancers are caused by talcum
 20 powder and talcum powder provides no medical
 21 benefit, the Hill criterion of strength of
 22 association is important and is met?
 23 MS. O'DELL: Object to the form. I don't
 24 think you read that --
 25 A I --

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1 MS. O'DELL: -- the report correctly. But
 2 if you were intending to read from her report
 3 verbatim, I don't believe that was correct.
 4 MR. ZELLERS: Counsel, please, just object
 5 to form, if you do have an objection.
 6 MS. O'DELL: I have an objection.
 7 A Could you -- again, you -- the -- what I
 8 believe has been -- within your statement, but
 9 that's not the reason I believe that the Bradford
 10 Hill criteria are met.
 11 Q (BY MR. ZELLERS) Well, let me ask you a
 12 question.
 13 A Yes.
 14 Q In your discussion of the Bradford Hill
 15 criterion of strength of association, you include
 16 Table 7, which is entitled "An Estimate of the
 17 Number of Ovarian Cancers and Invasive Serous
 18 Cancers Caused by Regular Use of Perineal Talc
 19 Powder Products"; is that right?
 20 A Yes.
 21 Q Is that a calculation that you did to try
 22 to determine whether or not there is strength of
 23 association?
 24 A No, but that's not why I included that.
 25 Q Well, is it included in your "Strength of

<p style="text-align: right;">Page 226</p> <p>1 Association" section?</p> <p>2 A It is included in the strength of</p> <p>3 association to demonstrate how -- an odds ratio of</p> <p>4 1.5, how many patients could be impacted on that.</p> <p>5 So one of the questions is: Is there a</p> <p>6 strong association? And the second, which is really</p> <p>7 quite a different question, is: What's the</p> <p>8 magnitude of that association?</p> <p>9 And sometimes the magnitude of the</p> <p>10 association is mistakenly used as an approximation</p> <p>11 of the strength of the association.</p> <p>12 And I was trying to disentangle the</p> <p>13 strength of the association. How truly do we know</p> <p>14 they're associated with -- if it is associated, how</p> <p>15 big of an impact would it have?</p> <p>16 And so the purpose of Table 7 is not in</p> <p>17 any way to demonstrate the strengths of the</p> <p>18 association, which is a requirement to assess for</p> <p>19 Bradford Hill --</p> <p>20 Q Would your --</p> <p>21 MR. LAPINSKI: She's not finished --</p> <p>22 A -- but how many --</p> <p>23 MR. LAPINSKI: -- Counsel.</p> <p>24 A -- but --</p> <p>25 MR. ZELLERS: Okay. Counsel, one lawyer</p>	<p style="text-align: right;">Page 228</p> <p>1 fine.</p> <p>2 MR. ZELLERS: Please don't interrupt</p> <p>3 the --</p> <p>4 MS. O'DELL: That's --</p> <p>5 MR. ZELLERS: -- deposition.</p> <p>6 MR. LAPINSKI: -- better. Thank you.</p> <p>7 MR. ZELLERS: Ms. O'Dell is doing a</p> <p>8 fabulous job of making objections --</p> <p>9 MR. LAPINSKI: Yes, she is.</p> <p>10 MR. ZELLERS: -- for all of you.</p> <p>11 Q (BY MR. ZELLERS) Okay. Doctor. You were</p> <p>12 trying --</p> <p>13 MS. O'DELL: Excuse me. I don't -- still</p> <p>14 don't think she was finished.</p> <p>15 MR. ZELLERS: Okay.</p> <p>16 MS. O'DELL: So you may continue, Doctor.</p> <p>17 If you were finished, great. If you weren't, you</p> <p>18 may finish your answer.</p> <p>19 A I -- I'm going to have to say I -- I -- so</p> <p>20 the -- the -- Table 7 is an illustration of the</p> <p>21 number of women who would be impacted.</p> <p>22 And the point was to explain that the</p> <p>23 strength of the association is separate from the</p> <p>24 number of women impacted. But indeed, it</p> <p>25 illustrates how important the number of women</p>
<p style="text-align: right;">Page 227</p> <p>1 can object. Okay. I don't want all of you</p> <p>2 objecting.</p> <p>3 MR. LAPINSKI: Don't -- don't raise your</p> <p>4 voice to me.</p> <p>5 MR. ZELLERS: No. I don't want all of you</p> <p>6 objecting.</p> <p>7 MR. LAPINSKI: Counsel, if you want to</p> <p>8 make a statement --</p> <p>9 MR. ZELLERS: Yeah --</p> <p>10 MR. LAPINSKI: -- make a statement.</p> <p>11 MR. ZELLERS: -- I'm making a statement</p> <p>12 that I do not want --</p> <p>13 MR. LAPINSKI: That's --</p> <p>14 MR. ZELLERS: -- the whole group of</p> <p>15 lawyers --</p> <p>16 MR. LAPINSKI: -- and you --</p> <p>17 MR. ZELLERS: -- on the Plaintiffs' side</p> <p>18 objecting.</p> <p>19 MR. LAPINSKI: -- I'm sitting directly</p> <p>20 across the table from you. And I can hear you, and</p> <p>21 I have heard you all day.</p> <p>22 MR. ZELLERS: Okay.</p> <p>23 MR. LAPINSKI: I have heard you carry on</p> <p>24 the way you have carried on all day. There's no</p> <p>25 reason to raise your voice to me. I can hear you</p>	<p style="text-align: right;">Page 229</p> <p>1 impacted is.</p> <p>2 Q Let's go through your math.</p> <p>3 A Yes.</p> <p>4 Q So the table, Table 7, includes several</p> <p>5 assumptions; is that right?</p> <p>6 A A great number of assumptions.</p> <p>7 Q You ran the data, assuming that 10 percent</p> <p>8 of the female population in the United States used</p> <p>9 talcum powder products regularly, as you define</p> <p>10 "regularly"; is that right?</p> <p>11 A Just to clarify, I -- I demonstrated what</p> <p>12 the impact would be if we estimated the number of</p> <p>13 women at 10 percent.</p> <p>14 Q You did the same calculation for</p> <p>15 20 percent and 30 percent; is that right?</p> <p>16 A Yes, I did.</p> <p>17 Q You don't actually know what percentage of</p> <p>18 women use talcum powder products regularly --</p> <p>19 A I --</p> <p>20 Q -- correct?</p> <p>21 A -- I do not.</p> <p>22 Q All right. The calculation -- or your</p> <p>23 conclusion is that .14 percent of women exposed to</p> <p>24 talcum powder products have invasive serous cancer.</p> <p>25 And I am looking at your 10 percent assumption that</p>

<p style="text-align: right;">Page 230</p> <p>1 you make.</p> <p>2 Did you mean .14 or did you mean for that</p> <p>3 to be 14 percent?</p> <p>4 A So I -- I take your correction as a -- as</p> <p>5 correct.</p> <p>6 Q Okay.</p> <p>7 A I do mean 14 percent, but -- but it's not</p> <p>8 the way you have interpreted it.</p> <p>9 The -- the -- the calculation -- the</p> <p>10 columns are the percent of invasive cancer that is</p> <p>11 attributable to talcum powder, not the proportion of</p> <p>12 cancer -- the proportion of women exposed who will</p> <p>13 develop cancer. Those are very different.</p> <p>14 Q I'm not sure I understand. Your column</p> <p>15 here says, The percent of invasive serous cancer in</p> <p>16 women exposed to talcum powder products; is that</p> <p>17 right?</p> <p>18 A That is correct.</p> <p>19 Q Okay. The universe of talcum powder</p> <p>20 products, which you're estimating here -- and I</p> <p>21 understand it's an estimation -- is 10 percent of</p> <p>22 the population; is that right?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A I -- I -- I -- I'm estimating in this</p> <p>25 table that 10 percent of women use talcum powder --</p>	<p style="text-align: right;">Page 232</p> <p>1 women get ovarian cancer. That would be five</p> <p>2 million women.</p> <p>3 I'm saying if we look at the world of</p> <p>4 invasive serous cancers in the United States, there</p> <p>5 will be in the ballpark of 11,000 serous cancers</p> <p>6 every year in the United States.</p> <p>7 Of those, 14 percent of those will occur</p> <p>8 in regular users of talc powders. 86 percent will</p> <p>9 occur in nonregular talc users.</p> <p>10 So you're interpreting what is listed as a</p> <p>11 column percent. It says, Percent of invasive serous</p> <p>12 cancer in women exposed to talc products.</p> <p>13 You're interpreting that as if I'm saying</p> <p>14 that the women exposed, that 15 percent of them will</p> <p>15 get ovarian cancer.</p> <p>16 Q And in fact, if -- if your caption is</p> <p>17 right, if we really are looking at the percent of</p> <p>18 invasive serous cancer in women exposed to talcum</p> <p>19 powder products, it would be less than .01 percent,</p> <p>20 right?</p> <p>21 A Um --</p> <p>22 MS. O'DELL: Object to the form.</p> <p>23 A -- you -- you're asking me how many women</p> <p>24 with exposure will end up getting?</p> <p>25 Q (BY MR. ZELLERS) Yes.</p>
<p style="text-align: right;">Page 231</p> <p>1 Q (BY MR. ZELLERS) Right.</p> <p>2 A -- products in the U.S.</p> <p>3 Q There are approximately -- what do you say</p> <p>4 -- 30 --</p> <p>5 A 311 million.</p> <p>6 Q -- all right. So 311 million. And you</p> <p>7 are estimating for purposes of this exercise that</p> <p>8 31,100,000 are regular users; is that right?</p> <p>9 A Yes.</p> <p>10 Q And what you are trying to determine is of</p> <p>11 those 31,100,000, what percent of regular talc users</p> <p>12 will have invasive serous cancer, correct?</p> <p>13 A Yes.</p> <p>14 Q And you have calculated 14 percent; is</p> <p>15 that right?</p> <p>16 A No.</p> <p>17 Q It's wrong, right?</p> <p>18 A The way you are describing it is wrong.</p> <p>19 But I can give you an example to help you understand</p> <p>20 that table.</p> <p>21 Q Well --</p> <p>22 A The number of cancers, we're talking about</p> <p>23 31 million women or women who were exposed to</p> <p>24 cancers.</p> <p>25 I'm not saying 13 -- 14 percent of those</p>	<p style="text-align: right;">Page 233</p> <p>1 A So that's a -- a good number. It's not</p> <p>2 one I presented, but certainly one I can estimate,</p> <p>3 which is -- if we're talking about 31 million women</p> <p>4 who have regular exposure and of those who will</p> <p>5 get -- I'm scribbling on my exhibit. I hope that's</p> <p>6 okay. Is that okay? One, two, three -- one, two,</p> <p>7 three. One -- one out of -- one out of 3,000 women</p> <p>8 will get --</p> <p>9 Q So --</p> <p>10 A -- ovarian cancer.</p> <p>11 Q -- approximately .01 percent, correct?</p> <p>12 A That sounds pretty good, actually.</p> <p>13 Q All right. Dose response. A significant</p> <p>14 number of the talcum powder studies that you looked</p> <p>15 at do not show a dose response or fail to account</p> <p>16 for dose response altogether; is that right?</p> <p>17 A In my summary of dose response on page 39,</p> <p>18 I note that Penninkilampi, one of the large</p> <p>19 meta-analyses, which I think is the most</p> <p>20 comprehensive review, talks about dose response.</p> <p>21 I didn't cite here -- and it was an</p> <p>22 oversight -- Berge, another large comprehensive</p> <p>23 meta-analysis, also shows dose response.</p> <p>24 So the two systematic reviews showed dose</p> <p>25 response. I also list Terry as showing dose</p>

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<p>1 response. That's the pool data of a large number of</p> <p>2 studies. Those are, you know, both quite -- I -- I</p> <p>3 have covered most of the publications, so those show</p> <p>4 dose response.</p> <p>5 There are a few others that I show. There</p> <p>6 are definitely a bunch that do not address the issue</p> <p>7 of dose response, but -- but I wouldn't characterize</p> <p>8 it as most do not.</p> <p>9 Q Well, you state on page 40 of your report</p> <p>10 with respect to dose response, The results are</p> <p>11 inconsistent and more importantly are not considered</p> <p>12 or assessed in most of the published studies.</p> <p>13 That was your conclusion with respect to</p> <p>14 dose response; is that right?</p> <p>15 A You are going to have to tell me where</p> <p>16 you're reading. What I'm reading says, In summary,</p> <p>17 most, but not all, studies of talcum powder products</p> <p>18 in ovarian cancer show a dose response.</p> <p>19 THE COURT REPORTER: Slow down when you</p> <p>20 read, please.</p> <p>21 A I'm so sorry.</p> <p>22 In summary, most, but not all, studies of</p> <p>23 talcum powder products in ovarian cancer show a dose</p> <p>24 response. Most do.</p> <p>25 But the results are inconsistent and more</p>	<p>1 A Yes.</p> <p>2 Q Would you agree that generally when you</p> <p>3 looked at the published studies, that they showed an</p> <p>4 association of around 1.3 between perineal talc use</p> <p>5 and ovarian cancer?</p> <p>6 A I think many of the studies showed an</p> <p>7 association of about 1.3 of any talc use. Not</p> <p>8 quantifying the amount of exposure.</p> <p>9 Q But would you agree that an -- that</p> <p>10 epidemiologists generally consider a 1.3 odds ratio</p> <p>11 in a case-control study to be a weak or modest</p> <p>12 association?</p> <p>13 MS. O'DELL: Object to the form.</p> <p>14 A I am -- I am unaware what -- of what most</p> <p>15 epidemiologists think.</p> <p>16 Q (BY MR. ZELLERS) Have you seen any peer</p> <p>17 reviewed literature on talc and ovarian cancer that</p> <p>18 states that 1.3 is a strong association?</p> <p>19 A I mean, Penninkilampi concludes there's a</p> <p>20 consistent association between perineal talc -- talc</p> <p>21 use and ovarian cancer.</p> <p>22 And I'm just looking for how he quantifies</p> <p>23 that. He concludes the results indicate that</p> <p>24 perineal talc use is associated with a 24 to</p> <p>25 39 percent increased risk of ovarian cancer.</p>
Page 235	Page 237
<p>1 importantly are not considered assessed in most --</p> <p>2 that -- that should not say "most." It should say</p> <p>3 "in many of the published studies."</p> <p>4 Q (BY MR. ZELLERS) All right. So you would</p> <p>5 amend your report from "most" to "many; is that</p> <p>6 right?</p> <p>7 A I -- I used "most" twice in the same</p> <p>8 sentence as meaning different things. So yes, I --</p> <p>9 Q Go --</p> <p>10 A -- it was an error.</p> <p>11 Q -- Gertig 2000 study found that there was</p> <p>12 no increase in risk of ovarian cancer with</p> <p>13 increasing frequency of use; is that right?</p> <p>14 A I would have to check that, but I'm happy</p> <p>15 to do so. I believe that's correct.</p> <p>16 Q Hunchcharek 2003 found that the data</p> <p>17 showed a lack of clear dose response relationship,</p> <p>18 making the relative risk of questionable validity;</p> <p>19 is that right?</p> <p>20 A Which -- which one?</p> <p>21 Q Sure. Hunchcharek 2003, page 19 of 55.</p> <p>22 A Wait. This one is 2011. I don't -- I</p> <p>23 don't think I have that one.</p> <p>24 Q All right. Consistency. Consistency is</p> <p>25 another factor that you looked at; is that right?</p>	<p>1 He doesn't quantify it as weak or strong,</p> <p>2 but there's a suggestion that a 39 percent increase</p> <p>3 is important. But he -- he doesn't quantify it. So</p> <p>4 I would have to look through the authors'</p> <p>5 conclusions.</p> <p>6 Q Do you know who Penninkilampi is?</p> <p>7 A I do not.</p> <p>8 Q Do you know that he is a medical student?</p> <p>9 A I'm very impressed. He did a beautiful</p> <p>10 review.</p> <p>11 Q Do you know who Guy Eslick is, the other</p> <p>12 author on that paper?</p> <p>13 A I do not.</p> <p>14 Q Do you know if he's an expert for the</p> <p>15 Plaintiffs in the talc litigation?</p> <p>16 A I -- I do not.</p> <p>17 MS. O'DELL: Object to the form.</p> <p>18 Q (BY MR. ZELLERS) Does Mr. Eslick disclose</p> <p>19 or identify that he is working for or has worked for</p> <p>20 Plaintiffs in the talc litigation?</p> <p>21 A I might -- I don't know the answer to</p> <p>22 that.</p> <p>23 Q You would expect that if that was true,</p> <p>24 that there would be a disclosure of that; is that</p> <p>25 right?</p>

<p style="text-align: right;">Page 238</p> <p>1 A I --</p> <p>2 MS. O'DELL: Object to the form.</p> <p>3 A -- it's published in a very high-impact,</p> <p>4 high-quality medical journal, and I would suspect</p> <p>5 that that would be required of that journal.</p> <p>6 But -- but I -- I -- I -- I don't -- I --</p> <p>7 I don't know that journal's requirements, but I</p> <p>8 would suspect that they would require reporting</p> <p>9 funding.</p> <p>10 Q You --</p> <p>11 A It says -- I'm sorry. It says, The</p> <p>12 authors report no conflicts of interest and have not</p> <p>13 reported funding.</p> <p>14 And typically when you have to reporting</p> <p>15 conflicts of interest in the same area, you also</p> <p>16 report funding, and I don't see any of that.</p> <p>17 Q The cohort studies. There are four cohort</p> <p>18 studies; is that right?</p> <p>19 A Yes.</p> <p>20 Q All right. You rely only on the Gertig</p> <p>21 study, the 2000 study; is that right --</p> <p>22 MS. O'DELL: Object to the form.</p> <p>23 Q (BY MR. ZELLERS) -- of those four?</p> <p>24 MS. O'DELL: Excuse me. Object to the</p> <p>25 form.</p>	<p style="text-align: right;">Page 240</p> <p>1 are summarized the way you summarized them. And I</p> <p>2 think if you look at them a little more closely, I</p> <p>3 would not make that conclusion. So --</p> <p>4 Q For the reasons set forth in your report?</p> <p>5 A It's in my report.</p> <p>6 MR. ZELLERS: All right. Let's take a</p> <p>7 break.</p> <p>8 THE VIDEOGRAPHER: We're off the record.</p> <p>9 The time is 3:58 p.m.</p> <p>10 (A break was taken from 3:58 p.m. to</p> <p>11 3:58 p.m.)</p> <p>12 (Next portion not on video record.)</p> <p>13 MR. ZELLERS: So we are back on the</p> <p>14 written record, but not the video record. My</p> <p>15 understanding is that, you know, we are taking a</p> <p>16 break as an accommodation to the witness, and that</p> <p>17 that's fine, but that, you know, you are not going</p> <p>18 to use this time to further meet and prepare the</p> <p>19 witness based upon the questions I asked today.</p> <p>20 MS. O'DELL: Correct. There's --</p> <p>21 there's -- Dr. Smith-Bindman is taking this break</p> <p>22 because she is still recovering from her concussion.</p> <p>23 There will be no meeting with</p> <p>24 Dr. Smith-Bindman. I do want to point out counsel</p> <p>25 for J&J seems to have dictated this requirement in</p>
<p style="text-align: right;">Page 239</p> <p>1 A My report summarizes all four of them, and</p> <p>2 that all went into the weight of my report.</p> <p>3 In terms of being included in any</p> <p>4 systematic review, only one of them was included in</p> <p>5 the systematic review.</p> <p>6 Q (BY MR. ZELLERS) If you looked just at the</p> <p>7 cohort studies --</p> <p>8 A Yes.</p> <p>9 Q -- you would not find a statistically</p> <p>10 significant association between perineal talc use</p> <p>11 and ovarian cancer, correct?</p> <p>12 MS. O'DELL: Object to the form.</p> <p>13 A I --</p> <p>14 MS. O'DELL: Excuse me. When -- when you</p> <p>15 get to a good stopping point, it would be good to</p> <p>16 take a break --</p> <p>17 MR. ZELLERS: Okay.</p> <p>18 MS. O'DELL: -- but whenever you're -- if</p> <p>19 you have a few more minutes, that's fine, but</p> <p>20 whenever you get to a good point.</p> <p>21 A -- so I summarize my view of the cohort</p> <p>22 studies, which are not exactly what you -- what you</p> <p>23 just summarized -- the way you just summarized them</p> <p>24 on page 21.</p> <p>25 So I think that often the cohort studies</p>	<p style="text-align: right;">Page 241</p> <p>1 order to accommodate the witness's situation.</p> <p>2 But I would just note the deposition</p> <p>3 protocol has no such restriction, and -- and so</p> <p>4 that -- to that degree, I would say we have no</p> <p>5 intent to prepare the witness any further.</p> <p>6 But we're not restricted from talking to</p> <p>7 the witness, and I don't want the record to suggest</p> <p>8 otherwise.</p> <p>9 MR. ZELLERS: We will see you tomorrow.</p> <p>10 MS. O'DELL: Thank you.</p> <p>11 THE VIDEOGRAPHER: We are back on the</p> <p>12 record at 4:01 p.m, and this is the end of Disc</p> <p>13 No. 4 in today's testimony of Dr. Rebecca</p> <p>14 Smith-Bindman. The time is 4:01 p.m.</p> <p>15</p> <p>16 (TIME NOTED: 4:01 p.m.)</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p> <p>25</p>

Rebecca Smith-Bindman, M.D.

Page 242

1 I, REBECCA SMITH-BINDMAN, M.D., VOLUME I, do
 2 hereby declare under penalty of perjury that I have
 3 read the foregoing transcript; that I have made any
 4 corrections as appear noted, in ink, initialed by
 5 me, or attached hereto; that my testimony as
 6 contained herein, as corrected, is true and correct.
 7 EXECUTED this _____ day of _____,
 8 20____, at _____, _____.
 9 (City) (State)
 10
 11
 12
 13
 14
 15 REBECCA SMITH-BINDMAN, M.D.
 16 VOLUME I
 17
 18
 19
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 21
 22
 23
 24
 25

Page 243

1 I, MARY J. GOFF, CSR No. 13427, Certified
 2 Shorthand Reporter of the State of California,
 3 certify;
 4 That the foregoing proceedings were taken
 5 before me at the time and place herein set forth, at
 6 which time the witness declared under penalty of
 7 perjury; that the testimony of the witness and all
 8 objections made at the time of the examination were
 9 recorded stenographically by me and were thereafter
 10 transcribed under my direction and supervision; that
 11 the foregoing is a full, true, and correct
 12 transcript of my shorthand notes so taken and of the
 13 testimony so given;
 14 That before completion of the deposition,
 15 review of the transcript () was (XX) was not
 16 requested: () that the witness has failed or
 17 refused to approve the transcript.
 18 I further certify that I am not financially
 19 interested in the action, and I am not a relative or
 20 employee of any attorney of the parties, nor of any
 21 of the parties.
 22 I declare under penalty of perjury under the
 23 laws of California that the foregoing is true and
 24 correct, dated this _____ day of _____, 2019.
 25 MARY J. GOFF

Page 244

1 ERRATA SHEET
 2 Golkow Litigation Services
 3 1650 Market Street, One Liberty Plaza, 51st Floor
 4 Philadelphia, Pennsylvania 19103
 5 877-370-3377
 6 CASE: Talcum Powder Litigation
 7 PAGE LINE FROM TO
 8 _____
 9 _____
 10 _____
 11 _____
 12 _____
 13 _____
 14 _____
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 16 _____
 17 _____
 18 _____
 19 _____
 20 _____
 21 REBECCA SMITH-BINDMAN, M.D., VOLUME I
 22 Subscribed and sworn to before me
 23 this _____ day of _____, 2019.
 24 _____
 25 Notary Public

Exhibit 45

**UNITED STATES DISTRICT COURT
DISTRICT OF NEW JERSEY**

**IN RE JOHNSON & JOHNSON
TALCUM POWDER PRODUCTS
MARKETING, SALES PRACTICES,
AND PRODUCTS LIABILITY
LITIGATION**

MDL NO. 16-2738 (FLW) (LHG)

THIS DOCUMENT RELATES TO ALL CASES

**RULE 26 EXPERT REPORT OF
REBECCA SMITH-BINDMAN, MD**

Date: November 15, 2018



Rebecca Smith-Bindman, MD

The Relationship Between Exposure to Perineal Talc Powder Products and Ovarian Cancer

Expert Report

Rebecca Smith-Bindman, MD

Professor, Radiology and Biomedical Imaging, Epidemiology and Biostatistics, Obstetrics,
Gynecology and Reproductive Science and Director, Radiology Outcomes Research Lab
University of California San Francisco

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I. Executive Summary

Substantial evidence supports a strong positive association between ovarian cancer and genital exposure to talcum powder products and that regular exposure to talcum powder products causes ovarian cancer in some women. Talc is a naturally occurring mineral used in cosmetic products because of its desirable chemical properties such as being soft and absorbent. Women who have had regular exposure of the genitals (specifically the perineal region from the pubic area to the anal area) to talcum powder products are at increased risk of developing invasive ovarian cancer, in particular serous cancer, the most common and most lethal form. In the United States, a substantial portion of women report having ever used talc powder products at some point in their life. The most commonly reported frequency of talcum powder product use is daily. Women who use talcum powder products daily increase their risk of developing ovarian cancer significantly. Regular exposure causes ovarian cancer in some women.

I was asked to review the medical and scientific literature regarding the relationship between genital talcum powder product use and ovarian cancer and determine whether the relationship is causal. For this extensive analysis and report, I applied the same methodology with the same scientific rigor that I use in my research and clinical practice. I reviewed 43 relevant publications presenting scientific data on the association between ovarian cancer and exposure to talc powder products: 4 cohort studies, 8 systematic reviews, 2 studies that pooled data from multiple individual studies, and 30 case-control studies. I also read numerous review articles, and systematic reviews on related topics such as those completed by the International Agency on Research on Cancer (IARC). I also completed my own, new systematic review on of the studies that I reviewed as part of this report. This report contains my overview of these publications plus a detailed new systematic review of the studies that I conducted. After reading, evaluating, and summarizing these publications, in my expert opinion, I do not have any uncertainty that regular exposure to talc powder products increases a woman's chance of developing epithelial ovarian cancer. In my expert opinion, regular exposure to talcum powder products causes ovarian cancer

Quantifying the precise magnitude of the association is more difficult than establishing the association. The association will certainly vary by demographic and reproductive factors and whether women have other underlying ovarian cancer risk factors and exposures. With that caveat, **it is my opinion that women exposed to perineal talc powder products on a regular basis have about a 50% increase in their subsequent risk of developing invasive serous ovarian cancer**, compared to women who do not regularly use talc and even after accounting for other ovarian cancer risk factors. This estimate is supported by existing publications and my quantitative review of the scientific literature that focused on summarizing studies that addressed regular exposure to talc powder products as a risk factor for epithelial ovarian cancer, and in particular serous cancer. Talcum powder exposure is associated with other epithelial cancer subtypes (in particular, clear cell and endometrioid carcinoma), but because these cancers are less common, and because fewer studies have evaluated these cancers in sufficient numbers, quantifying the associations is more difficult. While some publications estimated talc powder products have a slightly greater risk of these cancer subtypes, others

estimated a slightly lower risk of these cancer subtypes. In my opinion, this risk is likely overall in about the same range as for serous cancer, but I would estimate slightly less at 40% increased risk.

The epidemiological evidence documents a strong, positive association between exposure to talcum powder products and ovarian cancer and that regular exposure causes ovarian cancer. The epidemiological evidence alone does not confirm the mechanism by which talc powder product increases ovarian cancer risk, nor does it confirm the specific component in talcum powder products that makes it carcinogenic. Nonetheless, the literature provides compelling evidence that exposure to talcum powder products leads to chronic inflammation and that the inflammation induces a strong biological response that results in the induction, promotion, and growth of cancer. Further, there is evidence that several highly carcinogenic agents are components of the talcum powder products. These include, most importantly, asbestos, a Group 1 carcinogen that the International Agency for Research on Cancer (IARC) has determined causes ovarian cancer. I have seen evidence that talcum powder products contain asbestos. Second, talcum powder products contain asbestiform talc particles which have a similarity in structure to asbestos fibers (and which IARC concludes are carcinogenic). Lastly, talcum powder products contain numerous heavy metals such as, nickel, chromium, (Group 1 carcinogens) and cobalt (Group 2 carcinogen) according to IARC. These components are carcinogenic (cause cancer) and can contribute to the carcinogenicity of talcum powder products. Observational and experimental data confirm that talcum powder product particles applied to the perineum can reach the fallopian tubes and ovaries through the vagina, supporting that talc particles applied to the perineum can deposit on the ovaries. Surgery that impedes the movement of particles from the perineum to the ovaries such as hysterectomy (uterine removal) or tubal ligation (tying or blocking the fallopian tubes to the ovaries), reduces the elevated risk of ovarian cancer from exposure to talcum powder products. This finding supports that local tissue response and inflammation in the fallopian tubes and/or ovaries from talcum powder products (with components) causes the elevated ovarian cancer risk.

In summary, **from my review of the scientific literature and my own analysis, it is my opinion that genital exposure to talcum powder products is an actionable and causative risk factor for ovarian cancer.** As a physician involved in women's health issues, I view talcum powder usage as a modifiable "lifestyle" risk factor that should be avoided because of the substantial risk to health and lack of therapeutic benefit. An elevated risk of 50% is significant and results in a large number of unnecessary ovarian cancers given the large number of women exposed. Depending on estimates of how many women regularly use talcum powder products, between 7% and 20% of all ovarian cancers and 14% - 39% of invasive serous cancers (the most aggressive and feared cancer type) are caused by the use of talcum powder products. These cancers can be prevented if women do not use talcum powder products.

II. Qualifications

Education and Employment

I am a professor of Radiology and Biomedical Imaging, Epidemiology and Biostatistics, Obstetrics, Gynecology and Reproductive Medicine, and Health Policy at the University of California San Francisco (UCSF) School of Medicine. I graduated from Princeton University with a degree in structural engineering (with combined majors in engineering and architecture) and attended UCSF medical school. My training after medical school included an internship, radiology residency, and clinical fellowship in women's health and a research fellowship in epidemiology and biostatistics in the UCSF Departments of Medicine and Epidemiology and Biostatistics.

I am a clinician-scientist. My clinical work includes one day a week in the Department of Radiology and Biomedical Imaging, with a focus on women's health imaging. I work in the ultrasound section, where a large proportion of the work is focused on the diagnosis of ovarian abnormalities (cancer and other functional issues). I run the UCSF Radiology Outcomes Research Lab, spending most of my time on clinical research and leading large epidemiological studies. I teach in the UCSF School of Medicine and Department of Epidemiology and Biostatistics.

Research Expertise

My research expertise is in epidemiology, outcomes research, comparative effectiveness, health services research, and dissemination and implementation sciences. My epidemiological studies have evaluated the quality, use, accuracy, predictive value, and impact of diagnostic testing on patient health. I have measured the risks and benefits of medical imaging in different contexts and different populations. Much of the research is in women's health, including diagnoses of cancers such as ovarian, endometrial, thyroid and breast. I have led many large, multi-institutional research projects. These projects are typically collaborative, involving researchers and clinicians with diverse expertise including radiology, obstetrics and gynecology, medicine, biostatistics, epidemiology, economics, demography, social sciences, medical informatics, radiation science, and dissemination and implementation science.

I have been a prolific researcher. I have led projects funded by more than 50 million dollars in research grants—entirely focused on cancer diagnosis and prediction. The research has been published in the most prestigious medical journals including the *New England Journal of Medicine*, *Annals of Internal Medicine*, *Journal of the American Medical Association*, *Journal of the American Medical Association Internal Medicine*, *Journal of the National Cancer Institute*, *Obstetrics and Gynecology*, and leading radiology specialty journals such as *Radiology* and *Journal of the American College of Radiology*.

Knowledge of Relevant Study Designs

Several of my published studies have been systematic, meta-analytic, quantitative reviews of the published literature. Meta-analyses review existing evidence on a topic and summarize

and re-analyze data from earlier studies. My systematic reviews focused on the diagnoses of endometrial cancer, breast cancer, and a range of birth defects including trisomy 21 (Down syndrome) and trisomy 18 (Edwards Syndrome). Many of my reviews were published in prestigious medical journals, reflecting their scientific rigor based on an in-depth understanding of how to combine and review results from different studies in a scientifically valid and reproducible way.

Several of my recent research projects quantified the variation in radiation dose associated with medical imaging and the expected impact of this variation on cancer outcomes. This work has brought attention to the need for better standards in medical imaging. I am currently leading two large, multi-institutional epidemiological projects on medical radiation funded by the National Institutes of Health. One project is collecting radiation dose measures associated with computed tomography (CT) imaging from more than 150 hospitals in the United States, Europe, and Asia and testing the impact of providing feedback and education to radiologists on average and high doses. The second project is a multinational epidemiological study on childhood cancer. This project is assessing the risk of cancer associated with medical imaging among 1 million children and 1 million pregnant patients after accounting for a range of other cancer risk factors. The study will be the first to quantify the risk of medical imaging including CT among a large group of patients and uses novel methods to accurately estimate radiation dose from imaging.

I have expertise in a range of research study designs. The projects I currently lead (each funded by the National Institutes of Health or the Patient-Centered Outcomes Research Institute for between 9 - 15 million dollars each) have designs selected to be appropriate for the research question. For example, the study assessing the risk of cancer from medical imaging uses a *case-control study design, in which data are collected on a group of patients and those with a condition (cases), are matched to similar patients without the condition (controls)*. Matching people with a disease to people of similar age, gender, and other factors who do not have the disease allows researchers to determine if circumstances such as exposure to a potential toxin influence disease development.

My project on medical imaging uses a *cohort design, comparing groups of people (cohorts) in a population, some exposed to a potential disease agent and some not exposed*, to see if the agent influences disease. My study on radiation doses from CT uses a *randomized controlled design, in which individual patients are randomly assigned to different treatments* so their effectiveness can be compared. I am studying lung nodules using a *cluster-randomized controlled trial design that randomly assigns groups of people in similar circumstances (for example because they all see the same doctor) to different treatments* so the effects of the treatments can be compared.

I have a deep understanding of how epidemiological studies are conducted. I understand what study designs are suitable to particular datasets, populations, and research questions and the advantages and disadvantages of each design. This is relevant as no single study

design is “best;” there are strengths and weaknesses of each. The most appropriate and valid study design varies based on the research question being asked.

Experience as a Medical Expert

For the National Academy of Medicine, I have contributed to several reports, including Saving Women’s Lives (2004), Improving Mammographic Quality Standards (2005), and Breast and the Environment: A Life Course Approach (2012), for which I wrote a review on the association between radiation exposure and breast cancer (Appendix). In addition to this research, I am actively involved in raising awareness of the need for better standards and greater safety around medical imaging, in particular related to radiation exposure. I have spoken at the US Food and Drug Administration, testified before the US Congress on several occasions, and worked with leading professional societies to focus attention on improving medical imaging safety. I have written several quality measures on radiation dose adopted by the National Quality Forum and developed educational tools to help physicians and patients understand the importance of minimizing radiation exposure from imaging.

Prior to providing my opinions on the association between talcum powder products and ovarian cancer, I had not reviewed the relevant literature and had not published in this area. As a result, I brought an unbiased perspective to my review. This report reflects my review of medical and scientific publications in this area (overviews and scientific studies), my own analysis, and review of documents shared with me by the lawyers who engaged me for this task. My curriculum vitae is attached as Exhibit A, the materials I considered are attached as Exhibit B, and my fees and prior testimony are attached as Exhibit C.

III. Background: Ovarian cancer and Talc as a Modifiable Risk Factor

Ovarian Cancer

Ovarian cancer is the seventh most common cancer in women and the fifth leading cause of cancer deaths in the United States.¹ In 2018, 22,240 women are expected to receive a new diagnosis of ovarian cancer and 14,070 women will die from it. Overall, about 1 in 78 women (1.3%) will be diagnosed with ovarian cancer in their lifetime and around 1 in 108 will die of it. About 224,940 women are currently living with ovarian cancer.² Most cases occur among older women; the median age at diagnosis is 62, although this varies by ovarian cancer type.² Ovarian cancer is frequently diagnosed at a late stage, when a cure is unlikely. Because so many ovarian cancers are diagnosed at a late stage, the overall mortality rate is high, and the overall 5-year survival is poor. With the poor prognosis and absence of a reliable screening test to find ovarian cancer early, it is a highly feared cancer for women and their physicians alike.

Histologic types

Cancers are classified by histologic type, meaning the type of cells that are involved. Understanding ovarian cancer histologic types is important because the risk factors, etiology and genetics of ovarian cancer can vary by histological type. Therefore, the importance of talcum powder products as a risk factor or cause can also vary by type.

Ovarian cancers (epithelial and non-epithelial) are a heterogeneous group of malignancies that vary in their pathological appearance, molecular biology, risk factors, etiology and prognosis.¹ Epithelial ovarian cancers have several histologic types; most fall into a small group of more common types including serous, endometrioid, clear cell and mucinous. About 90% of ovarian cancers are epithelial (meaning they arise from cells on the surface of the ovary or fallopian tube) and the most common type of epithelial cancer is serous carcinoma. Serous is not only the most common type of ovarian cancer, it is also the most lethal type of ovarian cancer. Further, it is the type of cancer that pathologists can most consistently, reliably, and reproducibly diagnose. Thus, epidemiological studies will have the greatest ability to document a clear association between serous ovarian cancer types and talcum powder products, if a connection exists. It is also the subtype that has been studied most from a molecular and pathologic research standpoint.

Table 1. Histologic Types of Ovarian Cancers Diagnosed Over 15 Years at the KP Washington (in press, JAMA Internal Medicine)		
Histologic Type	Number	Percent of Total Cancers
Papillary serous cystadenocarcinoma	52	36.6
Endometrioid carcinoma	17	12.0
Serous cystadenocarcinoma	15	10.6
Clear cell adenocarcinoma	12	8.5
Adenocarcinoma, NOS	11	7.7
Mucinous adenocarcinoma	7	4.9
Mixed cell adenocarcinoma	3	2.1
Serous surface papillary carcinoma	3	2.1
Granulosa cell tumor	3	2.1
Carcinoma, not otherwise specific	2	1.4
Mucinous cystadenocarcinoma	2	1.4
Mucinous cystic tumor of borderline	2	1.4
Carcinoma in situ	1	0.7
Squamous cell carcinoma	1	0.7
Papillary adenocarcinoma	1	0.7
Papillary serous cystadenoma, borderline	1	0.7
Adenocarcinoma with squamous meta	1	0.7
Granulosa cell tumor, malignant	1	0.7
Endometrial stroma sarcoma	1	0.7
Mullerian mixed tumor	1	0.7
Carcinosarcoma	1	0.7
Carcinosarcoma, embryonal	1	0.7
Teratoma, malignant	1	0.7
Astrocytoma	1	0.7
Marginal zone B-cell lymphoma	1	0.7
Total	142	100
Summary		
Serous carcinoma	70	49.3
Endometrioid carcinoma	17	12.0
Clear cell carcinoma	12	8.5
Mucinous carcinoma	9	6.3

My research group recently reported on the ultrasound appearance of ovarian cancers among a large cohort of women. The purpose of this cohort study was to quantify the risk of malignant ovarian cancer based on ultrasound findings. We described 142 new ovarian cancer cases in a population of 500,000 women enrolled in Kaiser Permanente Washington, an integrated health plan, between 1997 and 2008, including 72,093 women who underwent pelvic ultrasound. The distribution of cancer histological types is in Table 1. Serous carcinoma was the most common cancer type: In our cohort, it was 50% of the ovarian cancers. Serous carcinoma has the worst prognosis of the ovarian cancer types. Its high frequency and poor

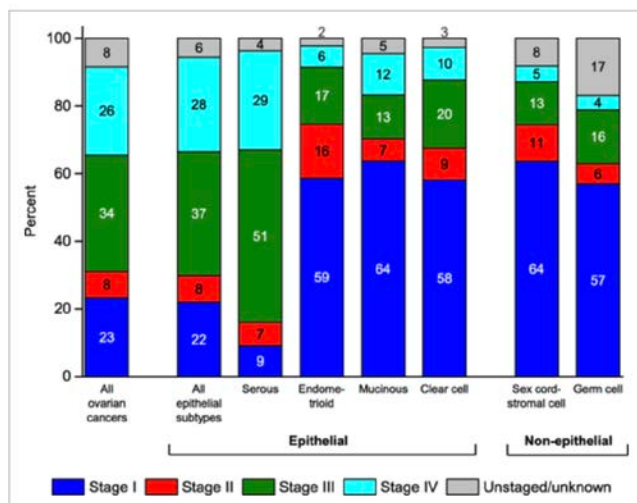
prognosis contribute to the high mortality rate for ovarian cancer overall. The other common histological types of ovarian cancer were endometrioid (12% in our data), clear cell (8.5% in our data), and mucinous (6.3% in our data).

Ovarian cancer types have large differences in stage of diagnosis (a strong predictor of survival) and prognosis independent of stage. The 5-year survival by histological type is in Table 2. Serous cancer is the most frequent and most aggressive, with an overall 5-year survival of 43% as compared with 82% for endometrioid. The survival is strongly influenced by stage at diagnosis, with higher stage numbers indicating more advanced stage.¹ Most serous carcinomas are diagnosed at stage III (51%) or IV (29%) (Figure 1),² for which 5-year survivals from the most recent data were 42% and 26%, respectively. These data reflect the aggressive nature of serous cancer.¹ In contrast, the majority (58% to 64%) of endometrioid, mucinous, and clear cell carcinomas are diagnosed at stage I, similar to nonepithelial tumors (Figure 1). Consequently, the 5-year survivals are 82%, 71%, and 66%, respectively, for endometrioid, mucinous, and clear cell carcinoma. Thus, these cancers behave very differently, even though all are ovarian epithelial cancers.

Table 2. Percent of Women Surviving 5 Years After Diagnosis by Epithelial Ovarian Cancer Type. Data From 2008–2013.

	All epithelial types	Serous	Endometrioid	Mucinous	Clear cell	Sex cord-stromal	Germ cell
Stage							
All	47	43	82	71	66	88	94
Stage I	89	86	95	92	85	98	99
Stage II	71	71	84	69	71	84	93
Stage III	41	42	59	30	35	61	90
Stage IV	20	26	29	13	16	41	69

Figure 1. American Joint Committee on Cancer Sixth Edition Stage Distribution (%) for Ovarian Cancer by Histology, US, 2007-2013, SEER 18 Registries, NCI, 2017. This shows that serious cancers are more likely to be diagnosed at state III, IV (green and teal), compared with other tumor types.



This summary reflects our current knowledge about ovarian cancer histologic types and their associated prognoses. As research results are reported, our knowledge will evolve. For example, recent studies suggest we need to improve our ability to distinguish between high-grade serous and endometrioid carcinomas. Other results suggest that many ovarian mucinous carcinomas are actually gastrointestinal tumors that metastasized to the ovaries and this realization is affecting the reported rates of ovarian mucinous carcinomas (which are declining).^{1,3,4} The categorization of noninvasive tumors classified as borderline is also under investigation and a topic of discussion in the field. These noninvasive tumors have historically been considered in the spectrum of ovarian cancer that have less aggressive behavior. However, many previously described borderline cancers are now generally considered non-malignant.

In summary, when assessing the carcinogenicity of talcum power products, this should focus on invasive serous carcinoma as the most important cancer (based on prognosis) and the most reliable cancer to identify (based on histology and understanding of cancer behavior).

Additionally, over the last decade, there has been research suggesting that many ovarian cancers originate from cells in the distal portion of the fallopian tube. Because the pathogenesis, treatment, and prognosis of serous cancers of the fallopian tube, ovary, and peritoneum are similar, these are now typically considered as a single entity.⁴ This consideration applies to the association with talcum powder product usage discussed in this report.

Risk Factors

Understanding ovarian cancer risk factors is important because analyzing the impact of talcum powder products exposure must consider *covariates, or other characteristics* that a woman might have that might also influence her ovarian cancer risk such as age, inherited genetic mutations, reproductive factors, or family history of cancer. Every risk factor does not have to be considered to come to a valid conclusion; indeed, this is not realistic within the limitations of medical research, and the bias introduced by the exclusion of some risk factors will be small. However, crude analyses that look at the risk of ovarian cancer from talcum powder products without adjusting for any other risk factors must be considered cautiously. For that reason, statistical analyses of research results often adjust for *confounding factors or variables that are covariates that hinder accurate calculation of an association*, for example between talcum powder products and ovarian cancer.

Numerous risk factors are identified for ovarian cancer.⁵ Unfortunately, few can be modified by therapies or lifestyle changes. Risk factors vary by histologic type⁵ but those that increase risk of ovarian cancer include personal or family history of ovarian or breast cancer, inherited mutations including BRCA1 and BRCA2⁶⁻¹⁰ advanced age, white race, increased education, and endometriosis. Other factors that may increase ovarian cancer risk due to estrogen exposure include having no pregnancies or advanced age at first birth, obesity, and postmenopausal hormone therapy.¹¹⁻¹³ Several factors are associated with reduced risk for ovarian cancer including breast feeding, multiple pregnancies, use of oral contraception,

tubal ligation, and removal of uterus, fallopian tubes, or both.¹⁴⁻¹⁸ Smoking is a possible risk factor for ovarian cancer, primarily mucinous subtype, although study results have not been consistent.^{5,19}

Risk factors vary by cancer type. For example, serous cancer is more strongly associated with reproductive risk factors than mucinous tumors²⁰⁻²² and different histologic types have different molecular and genetic profiles.²³⁻²⁵ Serous tumors are more likely to have a cancer-promoting mutation in the p53 gene, whereas similar KRAS mutations are more common in mucinous tumors. Over time, the occurrence of ovarian cancer has changed, in part due to changes in risk factors. For example, small declines in the rates of endometrioid and serous cancer are attributed to declining use of hormone replacement among postmenopausal women.

Etiology: Origins, Causes, Development and Inflammation

Our understanding of the etiology and course of ovarian cancer continues to evolve. Hereditary genetic predisposition increases risk, but overall, accounts for only a small proportion of cancers. And even in women with hereditary genetic mutations, not all will develop ovarian cancer. The majority of ovarian cancers are now believed to arise in the distal portion of the fallopian tube. By convention, fallopian tube, ovary and peritoneal cancers are considered as a single entity. The most widely accepted mechanism for initiation, promotion and progression of ovarian cancer is tissue inflammation leading to a series of responses that result in cancer.

There is very clear and extensive scientific literature describing the relationship between inflammation and cancer across many anatomic areas. Chronic inflammation, and even subtle, subclinical inflammation, is associated with an increased risk of cancer.²⁶⁻²⁸ Many inflammatory conditions predispose to cancer development. Diverse factors that lead to inflammation - infection, chemical exposures, physical agents, autoimmune factors, and even inflammatory reactions of uncertain etiology - can lead to an increase in cancer incidence. For example, there are well described and accepted causal pathways linking inflammation in the etiology of bladder cancer (schistosomiasis, toxic chemicals), cervical cancer (papillomavirus), gastric cancer (H Pylori), colon cancer (inflammatory bowel disease), liver cancer (hepatitis), mesothelioma (asbestos) and ovarian cancer (pelvic inflammatory disease and endometriosis). The biological pathways associated with inflammation include stimulation/interference with a range of biological responses that are involved in initiation of cancer, promotion of cancer, and progression of cancer. Oxidative stress resulting from inflammation can impact all stages of cancer development including cancer initiation (DNA is damaged by introducing gene mutations and structural alterations of DNA leading to inhibition of DNA repair and malignant transformation); promotion (which may be manifest as abnormal gene expression resulting in cell proliferation and decrease apoptosis) and progression (further DNA damage and enhancement of cell growth).²⁹ Local inflammatory response can lead to signaling molecules such as cytokines, chemokines, prostaglandins, growth transcription factors, microRNAs having higher expression that can promote cancer

development and can create a favorable microenvironment for the development and progression of cancer.³⁰ Inflammation impacts every step of tumorigenesis, from initiation through tumor promotion, and extending to metastatic progression. Similarly, the most compelling mechanism for the etiology of ovarian cancer is that of chronic inflammation and scarring in the ovary that leads to malignant transformation and cancer progression. This mechanism involves cell proliferation, oxidative stress, DNA damage and gene mutations.³¹⁻³³ The microenvironment of ovarian cancer contains a broad spectrum of pro-inflammatory cytokines and chemokines contributing to the mechanism.³⁸

There are many processes that can lead to inflammation and tumorigenesis and the exposure to talcum powder products is one such exposure that can strongly enhance the tumor promotion or progression as seen in in vitro and animal studies. For example, normal repeated ovulation leads to injury of ovarian epithelial cells and transformation to malignant cancer cells that can be enhanced by various factors such as talc or asbestos particles. Exposure to talcum powder products can induce the production of pro-oxidant enzymes and reduced production of antioxidant enzymes leads to malignant transformation. In support of inflammation from talcum powder products causing cancer, hysterectomy or bilateral tubal ligation, which would significantly limit ovarian exposure to inflammatory mediators, and toxins, is associated with reduced ovarian cancer risk.

Relationship Between Ovarian Cancer and Talcum Powder Products

The epidemiological evidence described in detail below demonstrates a strong and positive association between exposure to talcum powder products and ovarian cancer and that talcum powder products cause ovarian cancer. Although epidemiologic evidence alone does not provide a definitive mechanism or pathophysiological process that accounts for the increased risk, the evidence for inflammation as described above is very strong. Similarly, epidemiological evidence alone does not confirm the specific component or ingredient in talcum powder products that is responsible for its carcinogenesis. Nonetheless, several constituents within talc powder products are worth highlighting as they may be acting individually or together to create the carcinogenicity of talc powder products inasmuch as they are individually highly carcinogenic

Why Talcum Powder Products were Initially Suspected as Causing Ovarian Cancer

In 1978 samples of commercial body powders were shown to contain asbestos silica minerals. Asbestos was a known carcinogen and about half of the powder samples contained respirable quartz, a lung carcinogen. Concerns were primarily raised that inhaled powder could cause lung scarring, lung cancer, or mesothelioma. In 1971, Henderson observed talc particles deeply embedded in ovarian cancer tissue. The authors noted the close association of talc to the asbestos group of minerals.³⁹ Further concern was raised, in 1982 when a case-control study of ovarian cancer that collected information on talcum powder use reported an increased risk with perineal dusting.⁴⁰ These findings were reported in widely circulated newspapers such as The Globe, raising concern that the powders were carcinogenic because

of the contamination with asbestos, using the relationship between asbestos and lung cancer and mesothelioma as the basis for the concern.

Carcinomic of Constituents of Talc Powder Products

There are hundreds of different constituents and ingredients within talcum powder products in addition to platy talc. Many of these are Group 1 carcinogens (such as asbestos, talc containing asbestiform fibers, heavy metals, and some fragrance chemicals) that likely contribute to the carcinogenicity of the products.

Asbestos

Asbestos is the generic commercial designation for a group of naturally occurring mineral silicate fibers; serpentine mineral fibers are called chrysotile, and amphibole minerals include actinolite, amosite, anthophyllite, crocidolite and tremolites. Talc is formed by complex geological processes acting on pre-existing rock formations with diverse chemical composition. Small amounts of chrysotile (asbestos) may occur in these talc deposits^{41,42} When talc is mined it may contain asbestos fibers^{42,43} A study of 21 consumer talcum powders obtained from retail stores in 1971–1975 reported that 10 contained concentrations of asbestos fibers ranging from 0.2 to 14%.^{41,44} Because of concern that asbestos was present in talcum powder products and the known carcinogenicity of asbestos, it has been reported that voluntary guidelines were established by the cosmetic industry in 1976 to limit the content of asbestos fibers in commercial talc preparations. While currently talcum powder products are believed to free from asbestos, the data on its continued presences are strong. I have seen evidence of continued presence since 1976.⁴⁵⁻⁴⁸ For example, Longo tested approximately 50 samples that were taken between the years 1960 through 2000 and the majority of sample are positive for asbestos.⁴⁷

Asbestos is a known and potent human carcinogen. Asbestos is highly carcinogenic to the lungs, lining of the lungs, and larynx.⁴⁹ Asbestos is also highly carcinogenic to the ovaries.⁴⁹⁻⁵⁸ Women working in asbestos-manufacturing industries have an increased risk of ovarian cancer. IARC reviewed the association between asbestos exposure and ovarian cancer in 2012. To assess the relationship, IARC reviewed data primarily from large epidemiological cohort studies of women who had occupational exposure to asbestos as well case-control studies on non-occupational exposure. The context and lengths of exposures varied, along with the type of asbestos fibers to which the women were exposed and the study designs and assessments. Nonetheless, the results were consistent. Most, but not all, were statistically significant and documented a strong and compelling causal association between exposure to asbestos and ovarian cancer, largely the result of the association from cohort studies of women with substantial occupational exposures.⁵⁰⁻⁵⁴ **IARC concluded that there is sufficient evidence that asbestos is carcinogenic in humans and that asbestos causes cancer of the ovary.** This is the highest risk category.⁴⁹ IARC also concluded that this categorization applied to all forms of asbestos and to talc containing asbestiform fibers (talc in a fibrous habit or fibrous talc)). IARC also concluded that asbestos is carcinogenic based on animal studies. Camargo completed a systematic review of the relationship between women occupationally exposed to asbestos and ovarian cancer.⁵⁹ The authors found that of the 18 cohort studies

the pooled standard mortality estimate for ovarian cancer was 1.77 (95% confidence interval, 1.37-2.28). The range in reported SMR values was 1.1– 5.4 across the included cohort studies and the most common values were 2–3. This study supports IARC's conclusion that exposure to asbestos causes ovarian cancer.

IARC explicitly stated that the findings in this Monograph applied to all forms of asbestos, as well as asbestiform talc (fibrous talc).

I reviewed many publications and primary research studies, including experimental and basic science models showing molecular and genetic cancer-promoting changes to cells that occur from exposure to asbestos fibers. I also strongly conclude that asbestos causes ovarian cancer.

Talc

Talc is the primary component of talcum powder products. The chemical structures of talc and asbestos can be similar. While talc particles are usually plate-like, talc can also grow as a fiber which is similar to the group of minerals called asbestos. Both are magnesium silicate and when talc has the fibrous form it is called asbestiform because of its similarity to asbestos. The form of the talc fibers is long and thin, with parallel bundles that are easy to separate from each other, and closely resembles the physical appearance of asbestos minerals. The histologic appearances of mesothelioma and ovarian cancer are similar. The known carcinogenicity of asbestos for lung, pleural, peritoneal and ovarian cancer has led to the theory that the similarity in the fibers and the resulting cancers suggests that talc works mechanistically within the ovary to induce cancer in a way that is similar to how asbestos in the chest induces mesothelioma.

Early observations demonstrated talc particles in both malignant and normal ovaries establishing a route from the perineum to the ovary and shows that many women are exposed to talc.^{39,60} In 2006, the International Agency for Research on Cancer (IARC) reviewed the data on cosmetic (perineal) talc ("non-asbestiform") application and concluded that it is possibly carcinogenic to humans.⁶¹ This is not as strong a recommendation as they made for asbestos and ovarian cancer, but nonetheless is a strong recommendation. IARC classified genital-perineal use of talc-based powder as possibly carcinogenic. Exposure to talc particles can induce an inflammatory response, either directly at the ovary and ovary-fallopian tube juncture, causing local irritation from talc particulates or through more generalized peritoneal inflammation. The mechanism that can lead to cancer is local irritation by talc fibers that disrupts the epithelial surface, increasing rates of cell division and DNA repair that can lead to mutations. Also increased are oxidative stress and cytokine production, indicating inflammation. Fibers that are incorporated into the epithelial cells enter ovarian tissue. This inflammation initiates a series of responses, supported by research, that promote cancer. The reduction in the elevated risk of ovarian cancer from talcum powder exposure after hysterectomy or tubal ligation supports the mechanism by which local irritation and inflammation to the ovary from talc or asbestos causes an elevated cancer risk.

Heavy Metals

Talc powder products can contain Group 1 metals that are considered by IARC as carcinogenic to humans. ^{44,49}

This includes nickel compounds which IARC documents cause lung and nasal cavity and paranasal sinus cancer. (IARC100c-10, 2012). Nickel compounds “cause DNA damage, chromosomal aberrations, delayed mutagenicity and chromosomal instability ... and nickel compounds act as co-mutagens.” Talcum powder products also contain Chromium (VI) (IARC100c-9, 2012) another Group 1 carcinogen, where there is sufficient evidence in humans for carcinogenicity (to the nose and nasal sinus). The mechanism includes “DNA damage, generation of oxidative stress and aneuploidy. Talc powder products can also contain Group 2A metals that are considered probably carcinogenic to humans, such as Cobalt which can be found in talc powder products. ⁶² IARC considers Cobalt metal with tungsten carbide as probably carcinogenic to humans (Group 2A), but worth noting that a number of the IARC working group members supported an evaluation in Group 1 because they judged the epidemiological evidence to be sufficient, leading to an overall evaluation in Group 1; or they judged the mechanistic evidence to be strong enough to justify upgrading the default evaluation from 2A to 1. The majority of working group members, who supported the group 2A evaluation, cited the need for either sufficient evidence in humans or strong mechanistic evidence in exposed humans. Cobalt metal without tungsten carbide is also considered possibly carcinogenic to humans (Group 2B). Cobalt sulfate and other soluble cobalt(II) salts are possibly carcinogenic to humans (Group 2B).

Any and all of these heavy metals can cause ovarian cancer through an inflammatory mechanism

Fragrances

There are more than 150 different chemicals added to Johnson’s Baby Powder and Shower to Shower products. I reviewed the expert report from Dr. Crowley that concludes that some of these chemicals may contribute to the inflammatory response, toxicity, and potential carcinogenicity of Johnson & Johnson’s talcum powder products. I concur with his opinion. ⁶³

IV. Overview of Publications on Genital Use of Talc Powder Products and Ovarian Cancer

To understand the relationship between exposure to talcum powder products and ovarian cancer, I searched for and reviewed scientific papers on this topic. I used several searchable publication databases (Scopus, Embase, Pubmed) and manually searched the reference lists of all articles I found, including a large number of reviews. The results of my review follow the explanation of the main types of studies and articles.

Explanation of study designs and article types

Nearly all published studies that I reviewed used one of two designs: case-control and cohort. Each design has strengths and biases. The commonly held view is that cohort studies are better than case-control studies. This is a misconception thus it is worth explaining their differences. Many articles I reviewed were systematic reviews, which are also explained.

Case-control studies compare people with a condition (cases) by matching them to people with similar characteristics who do not have the condition (controls) to determine the effect of a potential disease-causing factor. They often analyze existing data retrospectively, after people have been diagnosed, and involve tens or hundreds of patients. Cohort studies compare cohorts, or groups of people, who were exposed or not exposed to a potential disease agent. They often collect data on people prospectively, before they develop a disease and track their health over time. Both case-control and cohort studies, if well done, can provide accurate and meaningful information about statistical associations. In general, however, the risk of bias is greater for case-control studies. (An example is recall bias, in which women are more likely to remember and report exposure to talc powder products after they have been diagnosed with cancer compared to women without a diagnosis, perhaps because diagnosed women heard that talc powder products is harmful and are more likely to remember talc use). Nonetheless, when studying a rare disease, the case-control design is frequently highly efficient and desirable as it allows you to assemble a much larger number of cases and can delve in great depth for particular exposures. You can identify all patients who have the outcome of interest, and then query them (and some control group) about any antecedent exposure. The identification of the control group is very important. My large, National Institutes of Health-funded study of cancer risk factors in children is employing a case-control design. This design permits us to ask very detailed questions of a small number of individuals about their various exposures.

Cohort studies potentially avoid some biases of case-control studies since exposures are prospectively assessed and quantified, that is, before disease outcomes. This design also has limitations, though. An extremely important limitation is that because cohort studies are expensive and time-consuming, they rarely focus on a single, narrowly defined question such as the association between regular use of talcum powder products and cancer. Usually, researchers investigate a broad range of questions in cohort studies, so asking patients in-depth questions about any given topic is difficult, especially since tens of thousands of patients may be surveyed on many topics. Further, in cohort studies, having comprehensive assessment of outcomes on all individuals in the cohort is extremely important. Losing patients to follow up (meaning researchers cannot contact or find records on a participant) leads to study bias. The other disadvantage of cohort studies is that a very large number of patients must be assessed over a long period of time to see who will develop a rare outcome (like ovarian cancer). Because of this, typically there will be far fewer patients with disease in a cohort study as compared with case control study (like in this case).

The small number of cohort studies I found on the relationship between talcum powder products exposure and ovarian cancer did not focus on the details of this topic. While they may have included questions about talcum powder exposure, they were not sufficiently nuanced to provide meaningful information. Thus, in most of the cohort studies I found, measurements of exposure were poor, not specific, or inaccurate. Further, several had very short follow-up periods with data or information about the time before the cancer occurred. This negates an advantage of cohort studies, which is being able to learn about exposures before the cancer, eliminating recall bias.

Systematic reviews quantitatively summarize results across multiple studies. One of the rationales of this study design is that individual studies may not have enough participants to yield meaningful results because they are too small or insufficiently powered. Combining small studies can provide more stable and reliable summary estimates of the effects of disease agents and risk factors. Further, a systematic review may be better than a single study, as it provides broader evidence of the results and includes patients from diverse settings. However, in order to statistically combine and summarize the data from different research studies into a single systematic meta-analytic review, the combined studies must ask the same research question and follow sufficiently similar and rigorous scientific methods. A meta-analysis does not compensate for gaps or flaws in an original study: Combining three poorly performed studies does not yield reliable summary estimates even though there may be three times the number of patients. Similarly, combining studies that ask different research questions (for example, assessing women of different ages for a disease in which age is an important risk factor) does not provide reliable summaries. Results from different studies often vary when the studies ask different research questions, have different criteria for including participants, or use different methods. I raise these issues to point out that systematic reviews must be read extremely carefully to ensure that their conclusions are valid.

Table of Reviewed Publications

I identified and reviewed 43 English-language publications that provided quantitative data based on epidemiological studies about the relationship between genital talcum powder exposure and ovarian cancer (Table 3). This list includes 4 cohort studies, 8 systematic meta-analytic reviews, 2 studies that pooled individual patient-level data from several research studies, and 30 case-control studies. One study contributed both the systematic review and a case control study. I also read multiple review articles that are not included in the table. The epidemiological studies were published between 1982 and 2018. I have described the results organized by study design below.

Most studies used a case-control study design with a small number using a cohort study design. Although some studies assessed powder use to any part of the body or assessed the use of talcum powder on diaphragms, condoms or sanitary napkins, the primary research question that I focused on in my review and that was assessed in all included individual research studies, was whether genital area exposure to talcum powder increases risk of epithelial ovarian cancer. Occasionally, study authors assessed combination exposures (i.e., to genitals and other body parts). These studies were included as long as genital powder use was assessed. Nearly all studies adjusted for known ovarian cancer risk factors, but those factors varied. The vast majority of studies found a positive association between any exposure to talcum powder products and cancer. However, the sample size of some studies was small and resulted in high statistical uncertainty. Because of these and other limitations, quantifying a precise association between exposure and cancer was difficult from my review of the literature. The data for some studies may have shown that effects of talcum powder exposure (measured as odds ratios, ORs) was meaningful for cancer development, but with statistical

uncertainty; whereas other studies showed the reverse results, with ORs not showing a positive association, but statistical parameters suggesting that a meaningful association was nonetheless possible because of wide confidence intervals. Therefore, I thought a more precise and careful review was called for. The number of individual women included in each study and the reported or estimated effect size for “any exposure to talc” (adjusted for other risk factors such as age) are in Table 4.

A subset of the studies quantified the *intensity (frequency)* of each woman’s exposure to talc to assess the importance of use patterns (e.g., if a single lifetime use or weekly, monthly, or daily use increased ovarian cancer risk) or *dose dependency (links between the number of exposures and cancer risk, e.g., if doubling exposure doubles risk)*. Further, a subset of studies stratified by cancer type (invasive vs. low malignant potential/borderline) and whether the risks varied by histological types including the four dominant types of serous, mucinous, clear cell, and endometrioid cancer.

Studies that provided data on the frequency of talc use and association by histologic type were included in a separate systematic meta-analytic review that I conducted as part of my review of the literature to include in this report. The reason I completed my own statistical review is further explained below.

Quantifying Exposures

A large proportion of women will have used talcum powder products, highlighting the importance of this issue. However, publications that focus on women reporting “any” genital exposure to talc (i.e., talc at any point in life and for any duration) may be too broad to provide meaningful information. For example, “any use” will include women who applied talc powder products three times over five decades and women who used talc powder products daily, whose might have had 20,000 applications and exposures in comparison to three. Defining a variable as any use is the equivalent to creating a variable of any smoking use, that combines data on individuals who tried one cigarette in their life with individuals with 50 pack years of tobacco use. Combining data on women with infrequent or sporadic exposures with data from women with frequent, sustained use leads to imprecise results, masking any causal associations. Therefore, I selected the studies for my own review that quantified the frequency of talc powder products use as having the most informative data and included them in a separate systematic review.

Summary of Data

I grouped the research studies by their study design. What follows is my review of the cohort studies, systematic review studies, pooled data studies, followed by my own review.

Cohort Studies

Four cohorts (Gertig, Gates, Houghton, Gonzalez) have been published on talcum powder products and ovarian cancer.

Cohort 1: Gertig (2000) ⁶⁴

This first cohort study assessed the relationship between perineal talc and ovarian cancer within the context of the US Nurses' Health Study, a prospective study of 121,700 female registered nurses in the United States who were aged 30–55 years at enrollment in 1976. These are mostly premenopausal women. While talc exposure was not an initial part of the study, questions about talc, including measuring frequency of exposure, were added in 1982; a large subset of the cohort (78,630 women) completed these questions and were included in analyses. Among these women who were followed for 14 years, 307 were diagnosed with epithelial ovarian cancer. After adjusting for confounding variables, the *relative risk (RR)* of developing ovarian cancer (*the likelihood of ovarian cancer in talc users compared to nonusers, with higher RR meaning increased risk stronger association*) among daily users of talc was RR 1.12 (95% confidence interval [CI] 0.82, 1.55, *a measure of statistical uncertainty, with wider ranges indicating greater uncertainty*), which was not statistically significant. However, when results were classified by histologic subtype, the RR of invasive serous cancers was significantly elevated among any users of talc (RR 1.40, 95% CI 1.02, 1.9) and the RR of invasive serous cancer among daily users of talc was higher at RR 1.49 (95% CI 0.98, 2.3).

In this cohort study, the researchers assessed talc exposure before cancer diagnosis, avoiding the possibility of the recall bias of case-control studies. This was a strong strength of this study. A potential weakness was that frequency (i.e. daily) but not duration (number of years) of talc use was measured, so a clear lifetime exposure measure was missing. The researchers nonetheless quantified exposure at the time the talc questions were asked, which was probably strongly associated with prior use (i.e. an approximation on ongoing use). **This study provides strong evidence that perineal exposure to talc increases the risk of invasive serous ovarian cancer, particularly among daily users of talc, with about a 50% increased risk,** which is substantial and meaningful.

Cohort 2: Gates (2010) ²⁴

This study assessed the association between ovarian cancer risk factors and incidence of ovarian tumors by histological type using data from the US Nurses' Health Study combined with data from the Nurses' Health Study II, which included a second period of enrolling participants. Unfortunately, talc use was assessed only on the first survey and not assessed among patients enrolled in the Nurses' Health Study II. Thus, this extends the period of follow up from the initial NHS but does not include greater information about risk factors. Results were presented for any talc powder products use and not for frequency of use. **Thus, this report does not add to a meaningful assessment of the relationship between talc use and ovarian cancer because it used exactly the same patient group as Gertig (2000) but provided less information to quantify the frequency of talc use.**

Cohort 3: Houghton (2013) ⁶⁵

This study assessed perineal talc powder products use and risk of ovarian cancer in the Women's Health Initiative Observational study, in which postmenopausal women aged 50–79 were enrolled in a prospective cohort of women from 40 clinical centers across the United

States in 1993–1998. Overall, 61,576 women were included in analyses, including 429 diagnosed with ovarian cancer. Perineal powder use was assessed at the start of the study. Participants were asked if they **ever used talc powder products** on their private parts (genital areas). Those who responded yes were asked about duration (years) of use. Women were followed for a mean of 12 years and the median age of participants was 63. **Talc powder products use was associated with a 12% increase in risk of ovarian cancer after accounting for covariates** (RR 1.12, 95% CI 0.92, 1.36). When limited to women who used perineal powder for 20 years or more, the RR was 1.10 (95% CI 0.82, 1.48). When limited to serous ovarian cancer, the RR was 1.13 (95% CI 0.84, 1.51.) **The primary limitation of the study was that frequency of talc powder products use was not assessed—and thus the authors could focus only on any talcum powder use.** The imprecision in estimation of talcum powder exposure makes the results not terribly meaningful. The second limitation was the relatively short follow-up of 12 years to identify ovarian cancer diagnoses.

Cohort 4: Gonzalez (2016) ⁶⁶

The Sister Study (2003–2009) followed 50,884 women ages 35 to 75 years in the US and Puerto Rico who had a sister diagnosed with breast cancer. After excluding participants who had bilateral oophorectomies, ovarian cancer, or were lost to follow-up, 41,654 participants were included. At baseline participants were asked about douching and talc use during the previous 12 months, and during follow-up (median of 6.6 years) 154 participants reported a diagnosis of ovarian cancer. The authors computed adjusted hazard ratios (HR) and 95% confidence intervals (CI) for ovarian cancer risk using the Cox proportional hazards model. The authors found no significant association between baseline perineal talc use and subsequent ovarian cancer (HR: 0.73 CI: 0.44, 1.2). **The primary limitations of this study are that the authors combined a large number of potential talc exposures into a single category, including genital talc use in the form of powder or spray applied to a sanitary napkin, underwear, diaphragm, cervical cap, or vaginal area. Further, the authors categorized the exposure based on the 12 months prior to enrollment as a dichotomous ever/never.** Thus not only was it an ever versus never category, the ever category was extremely broad, making the lack of association less meaningful. Further, there are several other factors that make the results questionable, including lower than expected proportion of women who report any exposure to talc powder products, and the lack of a validated approach to ascertainment of ovarian cancer.

Cohort Studies: Summary

Analyses of data from the US Nurses' Health study and the Women's Health Initiative estimated that women who report any exposure talc powder products will have a 12% increase in ovarian cancer compared to women who never report talc powder products use, although this estimate was not statistically significant. The primary limitation of this estimate is that it is based on *any talc powder products* use, which is a weak, crude predictor. Similarly, while the results from the Sisters study did not identify a significant association between talc powder products use and ovarian cancer, they too used a measure of ever use, and included a large number of different types of exposures that would not be expected to measure a single exposure. The most important and meaningful conclusion that I draw from the cohort studies

is from the Gertig 2000 study using data from the US Nurses' Health study: That women who are **daily users of talc have an approximately 50% increase (OR 1.49) in their risk of invasive serous** cancer, the most lethal and frequent type of ovarian cancer.

Systematic Reviews

I found nine systematic reviews that summarized the relationship between talc and ovarian cancer, summarized below. These reviews were completed using various subsets of the full list of publications. The systematic reviewers are presented with the most recent first, because the more recent studies tended to be more complete, comprehensive and the most methodologically rigorous.

Systematic Review 1: Penninkilampi (2018) ⁶⁷

This comprehensive systematic review of the association between any genital use of talcum powder products and ovarian cancer conducted a stratified analyses showing the association by frequency of talc use and histologic cancer subtype. The methods of the study are well described. The researchers identified studies using six electronic databases and reviewed publications with 50 or more cases of ovarian cancer. They identified 24 case-control studies describing 13,421 cases and the three cohort studies (890 cases, 181,860 person-years) described above. Any reported use of perineal talc powder products was associated with increased risk of ovarian cancer compared to no use (OR = 1.31; 95% CI 1.24, 1.39). Women with more than 3600 lifetime applications had slightly higher risks (OR = 1.42; 95% CI 1.25, 1.61). Women who reported long-term (>10 years) talc use also had an increased risk (OR 1.25; 95% CI = 1.10, 1.43). The association between any talcum powder product exposure and ovarian cancer was limited to studies that used a case-control design. The cohort studies showed an increased risk of serous invasive cancer subtypes for perineal talc use compared to no use (OR = 1.25; 95% CI = 1.01, 1.55). While serous and endometrioid cancer were associated with talcum powder products use, no association was seen with mucinous or clear cell cancers. The review authors concluded, from the data, that perineal talcum powder use and ovarian cancer were consistently associated, with a slightly higher risk in women who report greater usage. Some variation in the magnitude of the effect of talcum powder products was found when considering the study designs and ovarian cancer subtypes. Several small methodological issues are that Penniniklampi may have included some groups of patients more than once in analyses and did not include updated data or previously unpublished data available from a research consortium on ovarian cancer. However, these concerns are unlikely to have had a significant impact on their estimates.

Table 3. List of Included Studies, sorted by study design

	Study Type	Year	Author	Journal	Title
1	Cohort Study	2000	Gerting	J Natl Cancer Inst	Prospective study of talc use and ovarian cancer (in the Nurses' Health Study)
2	Cohort Study	2010	Gates	Am J Epidemiol	Risk factors for epithelial ovarian cancer by histologic type; US Nurses Health Study
3	Cohort Study	2014	Houghton	J Natl Cancer Inst	Perineal powder use and risk of ovarian cancer: Results from the Women's Health Initiative
4	Cohort Study	2016	Gonzalez	Epidemiology	Douching, talc use and risk of ovarian cancer: Results from the Sister Study
5	Systematic Rev.	1992	Harlow	Obst Gyn	Perineal exposure to talc and ovarian cancer risk
6	Systematic Rev.	1995	Gross	J Expo Anal Env Epid	A meta-analytical approach examining the potential relationship between talc exposure and ovarian cancer
7	Systematic Rev.	2003	Huncharek	Anticancer Res	Perineal application of cosmetic talc and risk of invasive epithelial ovarian cancer: a meta-analysis of 11,933 subjects from sixteen observational studies
8	Systematic Rev.	2007	Huncharek	Eur J Cancer Prev	Use of cosmetic talc on contraceptive diaphragms and risk of ovarian cancer: a meta-analysis of nine observational studies.
9	Systematic Rev.	2008	Langseth	J Epid Community Health	Perineal use of talc and risk of ovarian cancer.
10	Systematic Rev.	2010	IARC	IARC Monographs	IARC monographs on the evaluation of carcinogenic risks to humans: Carbon black, titanium dioxide, and talc
11	Systematic Rev.	2017	Berg	European J of Can Prev	Genital use of talc and risk of ovarian cancer: A meta-analysis
12	Systematic Rev.	2018	Penninkilampi	Epidemiology	Perineal talc use and ovarian cancer: A systematic review and meta-analysis.
13	Pooled Data	2013	Terry	Cancer Prev Res	Genital powder use and risk of ovarian cancer: a pooled analysis of 8525 cases and 9859 controls
14	Pooled Data	2016	Cramer	Epidemiology	The association between talc use and ovarian cancer- A retrospective case- control study two US states
15	Case-Control	1982	Cramer	Cancer	Ovarian cancer and talc: A case control study
16	Case-Control	1983	Hartge	JAMA	Talc and ovarian cancer
17	Case-Control	1988	Whittemoore	Am J Epidemiol	Personal and environmental characteristics related to epithelial ovarian cancer. Exposure to talcum powder, tobacco, alcohol, and coffee
5	Case-Control	1989	Harlow	Am J Epidemiol	A case-control study of borderline ovarian tumors: The influence of perineal exposure to talc
18	Case-Control	1989	Booth	BR Cancer	Risk factors for ovarian cancer: a case-control study
19	Case-Control	1992	Harlow	Obstet Gynecol	Perineal exposure to talc and ovarian cancer risk
20	Case-Control	1992	Rosenblatt	Gynecol Oncol	Mineral fiber exposure and the development of ovarian cancer
21	Case-Control	1992	Chen	Int J Epidemiol	Risk factors for epithelial ovarian cancer in Beijing, China
22	Case-Control	1993	Tzonous	Int J Cancer	Hair dyes, analgesics, tranquilizers and perineal talc application as risk factors for ovarian cancer
23	Case-Control	1995	Purdie	Int J Cancer	Reproductive and other factors and risk of epithelial ovarian cancer: an Australian case-control study
24	Case-Control	1996	Shushan	Fertil Steril	Human menopausal gonadotropin and the risk of epithelial ovarian cancer
25	Case-Control	1997	Chang	Cancer	Perineal talc exposure and risk of ovarian carcinoma
26	Case-Control	1997	Cook	Am J Epidemiol	Perineal powder exposure and the risk of ovarian cancer
27	Case-Control	1998	Green	Int J Cancer	Tubal sterilization, hysterectomy and decreased risk of ovarian cancer.
28	Case-Control	1998	Godard	Am J Obstet Gynecol	Risk factors for familial and sporadic ovarian cancer among French Canadians: A case-control study
29	Case-Control	1999	Cramer	International J of Cancer	Genital talc exposure and risk of ovarian cancer
30	Case-Control	1999	Wong	Obstet Gynecol	Perineal talc exposure and subsequent epithelial ovarian cancer: A case-control study
31	Case-Control	2000	Ness	Epidemiol	Factors related to inflammation of the ovarian epithelium and risk of ovarian cancer
32	Case-Control	2004	Pike	Fertil Steril	Hormonal factors and the risk of invasive ovarian cancer: A population based case control study
33	Case-Control	2004	Mills	Am J Epidemiol	Perineal talc exposure and epithelial ovarian cancer risk in the Central Valley of California
34	Case-Control	2008	Goodman	Endocr Relat Cancer	Association of two common single-nucleotide polymorphisms in the CYP19A1 locus and ovarian cancer risk
35	Case-Control	2008	Gates	Cancer Epid Bio Prev	Talc use, variants of the GSTM1, GSTT1, and NAT2 genes, and risk of epithelial ovarian cancer
36	Case-Control	2008	Merritt	Int J Cancer	Talcum powder, chronic pelvic inflammation and NSAIDs in relation to risk of epithelial ovarian cancer
37	Case-Control	2009	Moorman	Am J Epidemiol	Ovarian cancer risk factors in African-American and white women
38	Case-Control	2009	Wu	Int J Cancer	Markers of inflammation and risk of ovarian cancer in Los Angeles County
39	Case-Control	2011	Rosenblatt	Gynecol Oncol	Mineral fiber exposure and the development of ovarian cancer
40	Case-Control	2012	Lo-Cignaia	Epidemiol	Aspirin, non-aspirin non-steroidal anti-inflammatory drugs, or acetaminophen and risk of ovarian cancer
41	Case-Control	2012	Kurta	Cancer Epid Bio Prev	Use of fertility drugs and risk of ovarian cancer: results from a U.S.-based case-control study
42	Case-Control	2015	Wu	Cancer Epid Bio Prev	African Americans and Hispanics remain at lower risk of ovarian cancer than non-Hispanic whites after considering nongenetic risk factors and oophorectomy rates
43	Case-Control	2016	Schildkraut	Cancer Epid Bio Prev	Association between body powder use and ovarian cancer: the African American Cancer epidemiology Study

Table 4. List of Included Studies with Number of Cancers, Controls, and Reported Odds Ratios

	Study Type	Year	Author	Cancers	Controls or Cohort Size	Odds Ratio	95% CI
1	Cohort Study	2000	Gerting	307	78,630	1.12	(0.82,1.55)
2	Cohort Study	2010	Gates	797	108,073	1.06	(0.89, 1.28)
3	Cohort Study	2014	Houghton	427	61,576	1.12	(0.92,1.36)
4	Cohort Study	2016	Gonzalez	154	41,654	0.73	(0.44,1.2)
5	Systematic Review	1992	Harlow *	1,106	1,756	1.30	(1.1, 1.6)
6	Systematic Review	1995	Gross	1,333	2,362	1.29	(1.02, 1.63)
7	Systematic Review	2007	Huncharek	1,858	2,830	NA	NA
8	Systematic Review	2003	Huncharek	5,260	6,673	1.33	(1.16, 1.45)
9	Systematic Review	2008	Langseth			1.35	NA
10	Systematic Review	2010	IARC			1.30	
11	Systematic Review	2017	Berg	15,230	NR	1.22	(1.13, 1.30)
12	Systematic Review	2018	Penninkilampi	14,311	NR	1.31	1.24, 1.39
13	Pooled Data	2013	Terry	4,472	6,175	1.37	(1.19-1.58)
14	Pooled Data	2016	Cramer	2,041	2,100	1.38	(1.01,1.99)
15	Case-Control Study	1982	Cramer	215	215	1.58	(0.98, 2.47)
16	Case-Control Study	1983	Hartge	135	171	2.50	(0.70, 10.0)
17	Case-Control Study	1988	Whittemoore	188	539	1.45	(0.94, 2.22)
5	Case-Control Study	1989	Harlow	116	158	1.10	(0.70,2.1)
18	Case-Control Study	1989	Booth	235	451	1.30	(0.80,1.9)
19	Case-Control Study	1992	Harlow	235	239	1.80	(1.1, 3.0)
20	Case-Control Study	1992	Rosenblatt	77	46	1.70	(.70, 3.9)
21	Case-Control Study	1992	Chen	112	224	3.90	(0.9,10.6)
22	Case-Control Study	1993	Tzonous	189	200	1.05	(.28, 3.98)
23	Case-Control Study	1995	Purdie	824	860	1.27	(1.04, 1.54)
24	Case-Control Study	1996	Shushan **	200	408	2.00	NA
25	Case-Control Study	1997	Chang	367	564	1.51	(1.13,2.02)
26	Case-Control Study	1997	Cook	313	422	1.60	(0.9, 2.9)
27	Case-Control Study	1998	Green	824	855	1.30	(1.1, 1.6)
28	Case-Control Study	1998	Godard	170	170	2.49	(0.94,6.56)
29	Case-Control Study	1999	Cramer	563	523	1.60	(1.18, 2.15)
30	Case-Control Study	1999	Wong***	499	755	1.13	(0.89, 1.43)
31	Case-Control Study	2000	Ness	767	1,367	1.50	(1.1, 2.0)
32	Case-Control Study	2004	Pike				
33	Case-Control Study	2004	Mills	256	1,122	1.74	(1.14, 2.64)
34	Case-Control Study	2008	Goodman	367	602	0.99	(.70, 1.41)
35	Case-Control Study	2008	Gates			1.41	(1.14, 1.76)
36	Case-Control Study	2008	Merritt	1,576	1,509	1.34	(1.06, 1.68)
37	Case-Control Study	2009	Moorman	1,086	1,057	1.37	(1.05, 1.80)
38	Case-Control Study	2009	Wu	609	688	2.08	((1.34 3.23)
39	Case-Control Study	2011	Rosenblatt	812	1,313	1.13	(0.93,1.36)
40	Case-Control Study	2012	Lo-Cignaie	902	1,802	1.34	(1.07,1.66)
41	Case-Control Study	2012	Kurta	902	1,802	1.41	(1.16, 1.69)
42	Case-Control Study	2015	Wu	1,701	2,391	1.46	(1.27,1.69)
43	Case-Control Study	2016	Schildkraut	584	745	1.71	(1.26, 2.33)

Odds ratio, likelihood (odds) that an outcome will occur because of a particular exposure compared to the likelihood it will occur without the exposure. 95% CI, 95% confidence interval, a measure of statistical uncertainty that says with about 95% of the time that the true value is within the range of numbers. The wider the range, the higher the uncertainty. NR, not reported.

* crude unadjusted estimate

** approximate, unadjusted estimate

*** assessed perineal or thigh use, and controls all have cancer

Berge (2018) ⁶⁸

This large, comprehensive systematic review of the association between genital use of talc powder products and ovarian cancer also had well-described methods. Berge reviewed and abstracted data for 27 publications and reported an overall summary estimate of the association between talc exposure and ovarian cancer. For six of the reviewed studies, Berge included data published in a pooled data analysis, from Terry ⁶⁹ described below) that had not been previously included in the original publications. Overall, data on 15,230 women with ovarian cancer were analyzed (a number that is incorrectly reported in the paper). This is slightly higher than the number included in Penninkilampi because of the additional patients from the Terry publication. The summary estimate for risk of ovarian cancer for women who ever used genital talc was RR 1.22 (95% CI 1.13, 1.30). When stratified by histologic type, serous carcinoma was the only type with a significant association to talc use (RR 1.24, 95% CI 1.15, 1.34). There was no difference in risk when tumors were categorized as invasive versus borderline.

To assess relationships among ovarian cancer and intensity and duration of use, these measures were analyzed separately rather than as a combined measure that would give an estimate of the total number of exposures; the analyses did not demonstrate a significant dose response. Importantly, these measures were assessed only in five studies with the results on frequency of use presented as increased risk per additional day per week of talc use, which assumes a very linear association. I was not able to identify the original studies used in the review that reported the results with this level of granularity. Because of the small number of studies, the results (3% increase in risk per additional day of talc used, with high statistical uncertainty) were not surprising.

The authors also stratified the results by the study design (as did Penninkilampi) and found that the association between talc exposure and ovarian cancer was significant only for the case-control studies, although, as above, the cohort studies had the weakest definition of exposure. The primary limitation of the review is defining exposure as ever having used talc. As described above, this is a broad, vague definition that probably dilutes any estimated association, as it includes both women with trivial use and with regular use. A second limitation is that the included studies adjusted for a variety of covariates although this is unavoidable in this type of summary. The large difference in general between adjusted and crude results emphasizes the importance of adjustments when estimating particular risk.

Langseth (2008) ⁷⁰

This systematic review of the association between genital use of talc powder products and ovarian cancer included 21 publications. The overall pooled odds of cancer were OR 1.35 across all studies. Several authors of this systematic review were involved in an IARC report on talc exposure. They analyzed a subset of eight studies used in the IARC report that were considered to be the most informative for estimating ovarian cancer risk. Analysis of these more relevant, higher quality studies, produced an increased ovarian cancer risk of 30 to 60% (presumably OR 1.3–1.6) associated with talcum powder use. This subset analysis did not document a dose response or assess associations by cancer types.

Huncharek (2007) ⁷¹

Huncharek summarized the results of nine studies that reported on the association between talc used on contraceptive diaphragms and ovarian cancer. No data on perineal talc exposure were analyzed and the data are not included herein. Of note, the reported methodological details suggest a very poorly designed and conducted study. Some of the included papers do not even mention talcum powder products used with diaphragms. This systematic review is poor quality.

IARC (2006) ⁶²

Beginning in 1969 the International Agency for Research on Cancer (IARC) began a program to critically review the data on the carcinogenic risk of chemicals to humans. They subsequently expanded their reviews to include evaluation of carcinogenic risks associated with a range of exposures (including risks associated with biological and physical agents, lifestyle factors, complex mixtures of exposures, occupations, etc.) The purpose of the IARC program is to elaborate and publish detailed monographs including critical review of data, to evaluate human risks, and to indicate where uncertainty exists and where additional data are needed. They also give an overall assessment of the strength of the associations. It is worth noting that the individuals who contribute to IARC reports (the Working Group) include extremely knowledgeable and unbiased scientists who have specific content expertise and who have no apparent conflicts of interest. Invited specialists and representatives from international health agencies are brought in to supplement the scientific experts. In their evaluation, they heavily weight whether data support a conclusion of causality. They score evidenced into four categories, ranging from a) evidenced suggesting lack of carcinogenicity; b) inadequate evidence of carcinogenicity c) limited evidence of carcinogenicity and d) sufficient evidence of carcinogenicity. Category c is used when there is possibly carcinogenicity, and this category is not used lightly. An exposure meets category c if there is a positive association between observed exposure to the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance of bias or confounding could not be ruled out. They further categorize agents into 3 groups: Group 1, corresponding to d above (sufficient evidence), the agent is carcinogenic to humans; Group 2, which includes 2A (the agent is probably carcinogenic) and 2B: the agent is possibly carcinogenic to humans. A review focused on the risks associated with carbon black, titanium oxide and talc was published in 2006. The review included a detailed review of the individual studies examining perineal talc use as a risk factor for cancer. IARC concluded that perineal use of talc-based body powder is possibly carcinogenic to humans (Group 2B)

Huncharek (2003) ⁷²

This review of 16 studies assessed the relationship between genital exposure to talc and ovarian cancer using data for 5260 women with cancer and 6673 controls. The pooled OR for ever being exposed to perineal talc powder products was 1.33 (95% CI 1.16, 1.45). Small differences were observed in the estimated ORs by whether controls in the case-control studies were from hospital populations (OR 1.19, 95% CI 0.99, 1.4), or the general population (OR 1.38, 95% CI 1.25, 1.52). I believe these differences are small. In general, in case-control

studies, population controls are likely more relevant and valid. However, as with several of the other reviews, talcum powder exposure was assessed as any exposure rather than quantifying by intensity. No stratification by tumor subtype or invasiveness was performed.

Gross (1995) ⁷³

Gross reviewed 10 studies on the association between talc exposure and ovarian cancer using data on 1333 women with cancer and 2362 without cancer. To summarize the RR of malignant epithelial cancer types due to any exposure to talc, adjusting for ovarian cancer risk factors, the authors combined results from five studies for OR 1.29 (95% CI 1.02, 1.63). For an analysis of all cancers (borderline and invasive), they included data from seven studies for a similar OR of 1.31 (95% CI 1.08, 1.58). Notably, the authors did not provide any methodological details of how they identified, assessed, and combined studies, making the results difficult to fully interpret. As with several of the other reviews, they assessed any exposure to talc.

Harlow (1992) ⁷⁴

Harlow reviewed five previously published studies and summarized an OR, not adjusted for confounding factors, and added his own data for a crude estimated OR of 1.3 (95% CI 1.1, 1.6). Unfortunately, no methodological details were provided on how studies were identified, assessed, and combined or how exposure was defined, making the results difficult to fully interpret. Further, only the combined, estimated, non-adjusted crude OR was reported. Of note, the results of the five published studies used in the review (in contrast to the summary) are well described and of good methodological quality.

Systematic Reviews: Summary

The systematic reviews provide a remarkably consistent estimate of an approximately 30% increase in the risk of ovarian cancer associated with any talc powder products use. The studies summarized in the systematic reviews reported consistent results with little variability and closely overlapping estimates for ovarian cancer risk due to talc use. Further, the reviews suggest that the risks are greater for invasive serous cancer. I believe Penninkilampi provides a comprehensive and high quality review and his estimate is that women who regularly use talc powder products, defined as >3600 lifetime applications, have a 40% increased risk of ovarian cancer compared to women with no regular talc powder product use. The association was significant for serous cancers.

While the methodological approaches of these systematic reviews were generally valid, I believe they all shared the weakness of focusing on any talcum powder use rather than daily talcum powder use, and this motivated my own review (below).

Pooled Data

Two large studies pooled data from several studies. They are worth describing because of their larger sample size and strong methodology in comparison to the individual case-control studies.

Pooled Data 1: Terry (2013)⁶⁹

This report pooled data on ovarian cancer patients from a national research consortium and assessed the relationship between talc powder products exposure and ovarian cancer by histologic subtype and invasiveness. Data were from eight case-controlled studies and importantly included previously unpublished data. The authors tried to unify definitions across the studies, but the definitions nonetheless varied widely. The prevalence of genital powder use in the controls varied widely across participating study sites, ranging from 15%–45%, suggesting either large variations in the underlying populations or, probably more likely, variation in the definition of powder use that led to these differences.

The data were for a total of 8525 cases and 9859 controls in the primary analysis. The authors found that **genital talcum powder use was associated with an approximately 24% increased risk of epithelial ovarian cancer (OR 1.24, 95% CI 1.15, 1.33)**. When stratified by cancer type, the risk was increased for all cancers except mucinous cancer. Risks were approximately equally elevated for invasive and borderline tumors. They used a subset of patient data to determine RR of ovarian cancer for the highest talcum powder users, measured as cumulative lifetime perineal applications (defined as applications per month and months of the year). They also considered age (inclusion in the highest user group required more use at age 70 than age 40) and assessed risk of cancer among the highest users. **The odds of cancer in the highest talc exposure category was higher than for women who ever used talc (OR 1.37, 95% CI 1.19, 1.58)**. A significant dose response was seen when data on all patients were analyzed, with greater exposure leading to greater risk.

Pooled Data 2: Cramer (2016)⁷⁵

Cramer conducted several case-control studies on the relationship between genital talc powder use and ovarian cancer. He pooled data from a large number of these studies, described as reflecting study enrollment in 1992–1997, 1998–2002, and 2003–2008. This publication reports the analysis of pooled data from these separate enrollment phases and a more detailed characterization of those data. Cases were women who resided in Eastern Massachusetts and New Hampshire diagnosed with epithelial ovarian cancer between the ages of 18 and 80. Controls were women identified through random-digit dialing, driver's license lists and town resident lists. Women were interviewed in person, and details of talc use were elicited including the number of applications per month (allowing assessment of frequency of use), timing of use, and lifetime exposures. These descriptions gave far greater detail than most other reports and are thus an important contribution to the field. Further, more demographic and clinical history were obtained and described in these enrollments than for other reviewed studies. This report gave associations from pooled data for 2041 cases and 2100 controls. The larger size of the population, unified variables, and greater detail about cases and controls allowed a larger number of stratifications than other studies.

Overall, genital talc use was associated with an OR of 1.33 (95% CI 1.1.6, 1.52). An important observation was that risk decreased with time since last use. Thus, how often women regularly used talcum powder (daily, or weekly or monthly) was meaningful for predicting ovarian cancer risk, but not if the women had not used talcum powder for 5 or more years.

Women who reported using talcum powder daily (>30 applications per month) had an OR of 1.46 (95% CI 1.2, 1.78). Of note, among women in the ovarian cancer case group who used talcum powder, daily was the most commonly reported frequency of use. **When analysis used data on women who reported their total number of talcum powder applications, those in the highest group category (>7200 lifetime applications, the equivalent of 20 years of daily application) had an OR for ovarian cancer of 1.49 (95% CI 1.06, 2.1).**

Cramer conducted detailed analysis of factors that could influence/interact with the association between talcum powder and ovarian cancer. Some of the results are quite striking. First, a very strong interaction with race was noted. **African-American women seem to be at a particularly elevated risk of ovarian cancer following talcum powder exposure (OR 5.08, 95% CI 1.32, 19.6) compared with white women (OR 1.35, 95% CI 1.17, 1.55).** This finding calls for greater research given the higher incidence, and poorer outcomes among African American women. Asian women seem to be at reduced risk (OR 0.04, 95% CI 0.01, 0.34). **Analysis showed a strong relationship with menopausal status and use of hormone replacement therapy.** ORs were significantly increased in premenopausal women (OR 1.41, 95% CI 1.13, 1.75) and **postmenopausal women who used hormone treatment (OR 2.21, 95% CI 1.63, 3.0).** Postmenopausal women who did not use hormone therapy were not at increased risk of ovarian cancer (OR 1.0, 0.68, 1.49). **Interestingly, the risk of ovarian cancer among postmenopausal hormone-treatment users was elevated only if they used hormones before hysterectomy and tubal ligation but risk was substantial (OR 3.49, 95% CI 1.39, 8.75) if talcum powder was used before these surgeries (OR 5.85, 95% CI 2.89, 11.9) compared to talcum powder use both before and after surgery.**

These findings merit further assessment in other populations but raise the possibility that estrogen is important in ovarian carcinogenesis. The authors also stratified analyses by histologic type and found that the relationship between ovarian cancer and frequency of talcum powder use was significantly elevated for invasive and borderline serous cancer and invasive endometrioid cancer, but not for mucinous, clear cell or mucinous borderline cancer. **Among the most frequent users of talc the adjusted OR for invasive serous cancer is 1.54 (95% CI 1.15, 2.07).** This relationship was even stronger among premenopausal women (OR 1.85, 95% CI 1.21, 2.8) compared to postmenopausal women (OR 1.33, 95% CI 0.96, 1.85).

Pooled Data of Case-Control Studies: Summary

The increased risk of ovarian cancer associated with talc use was estimated at around 40% across these studies. The increased risk for serous cancer was even higher at 50%.

Case-Control Trials

A large number of case-control studies are published—too many to dedicate a paragraph to summarizing the methods of each.

21,24,36,40,74,76-99

I carefully read and abstracted data from each study. Without assessing the quality of the case-control studies, I included them in a table and sorted them by size of the reported effect

of talc on ovarian cancer risk. It's a way to get an overview of what they report – and Viewing them in this way is easy to see the general direction of the effect. All but two demonstrate a positive association ($OR > 1$) between any talc powder products use and ovarian cancer, with ORs ranging from 0.73–3.9 across studies, Table 5 .

Table 5: List of Case-Control Studies Sorted by Estimated Effect Size (Odds Ratio)

Year	First author			Odds ratio	Confidence interval
	2008	Goodman	367	602	0.99 (.70, 1.41)
1993	Tzonous	189	200	1.05	(.28, 3.98)
1989	Harlow	116	158	1.10	(0.70,2.1)
1999	Wong*	499	755	1.13	(0.89, 1.43)
2011	Rosenblatt	812	1313	1.13	(0.93,1.36)
1995	Purdie	824	860	1.27	(1.04, 1.54)
1989	Booth	235	451	1.30	(0.80,1.9)
1998	Green	824	855	1.30	(1.1, 1.6)
2008	Merritt	1576	1509	1.34	(1.06, 1.68)
2012	Lo-Cignaia	902	1802	1.34	(1.07,1.66)
2009	Moorman	1086	1057	1.37	(1.05, 1.80)
2008	Gates			1.41	(1.14, 1.76)
2012	Kurta	902	1802	1.41	(1.16, 1.69)
1988	Whittemoore	188	539	1.45	(0.94, 2.22)
2015	Wu	1701	2391	1.46	(1.27,1.69)
2000	Ness	767	1367	1.50	(1.1, 2.0)
1997	Chang	367	564	1.51	(1.13,2.02)
1982	Cramer	215	215	1.58	(0.98, 2.47)
1997	Cook	313	422	1.60	(0.9, 2.9)
1999	Cramer	563	523	1.60	(1.18, 2.15)
1992	Rosenblatt	77	46	1.70	(.70, 3.9)
2016	Schildkraut	584	745	1.71	(1.26, 2.33)
2004	Mills	256	1122	1.74	(1.14, 2.64)
1992	Harlow	235	239	1.80	(1.1, 3.0)
1996	Shushan **	200	408	2.00	NA
2009	Wu	609	688	2.08	((1.34 3.23)
1998	Godard	170	170	2.49	(0.94,6.56)
1983	Hartge	135	171	2.50	(0.70, 10.0)
1992	Chen	112	224	3.90	(0.9,10.6)
2004	Pike			NA	

V. Rationale for and Explanation of the New Systematic Review

In previous systematic reviews that I have conducted, I have obtained the most meaningful and consistent results by narrowly defining the research topic of the review, including only studies that provide data on this narrow topic in a well-defined population and stratifying my analysis of the studies' results by relevant factors such as age or race/ethnicity. The benefit of this approach is more accurate, precise, and meaningful results, while the potential tradeoff is a reduction in general applicability of the results, because many studies may be excluded for inadequate data. I believe greater accuracy is more important because I want to be certain about the data I am describing. For example, when I conducted a systematic review on the use of transvaginal ultrasound as a diagnostic test for endometrial cancer, I initially stratified

the results by patient use of hormone therapy. The reviewed studies had consistent results, but only if profoundly different diagnostic criteria were applied for women who did and did not use hormone therapy. For this reason, I completed one review on hormone users and another on non-users. In this case, I had sufficient data to assess both groups.

In this review on talcum powder use, I had sufficient data to summarize results for regular users of talcum powder (as close to daily but reflecting use of talc powder products several times per week) and risks of serous cancer; I did not have sufficient data to summarize results for occasional users or risk of other cancer types. I believe the most important research question to answer in this review is whether regular exposure to talcum powder is associated with ovarian cancer. I want to point out that this does not mean that other uses (i.e. less than approximate daily use) does not cause ovarian cancer, nor that talc powder products does not cause other types types of ovarian cancer (e.g. endometrioid cancer). Thus, for the systematic review below of case-control studies on the relationship between perineal exposure to talcum powder products and ovarian cancer, I focused on whether regular use of perineal (genital) talc increases the risk of the ovarian cancer. When possible, I focused on the most common and serious type, invasive serous ovarian cancer.

VI. New Systematic Review of Literature Quantifying Association Between Regular Frequent Genital (Perineal) Talcum Powder Products Application and Ovarian Epithelial Cancer Risk with A Focus on Invasive Serous Cancer.

Literature Search

I performed a literature search to identify primary research studies (not reviews) that included patient-level data on the association between talc and ovarian cancer. The literature search was performed in the Medline, Embase, and Scopus databases using keywords “ovarian cancer,” “talc,” “perineal powder” and “genital powder.” Abstracts of resulting publications were reviewed to identify if they addressed the topic and included data. Only English-language articles were reviewed. The references of identified articles and reviews were scanned to identify additional publications. Review articles, editorials, letters to the editor were excluded.

Article Selection

Articles were included based on relevance to the question: **Does the regular (as close to approximately daily) use of genital (perineal) talcum powder increase invasive epithelial ovarian cancer?** Because daily use was the most dominant use category, when studies stratified their results into quartiles of use, or lifetime applications, I included the highest use category that had a reasonable number of data points to reflect daily use. Wherever possible, data on invasive serous cancer were abstracted separately. When I found duplicate reports on the same patient group, the largest and most detailed publication was included. This usually meant the most recent publication, but not always. An important caveat is that I could not always identify duplicative results. I included data from the Terry 2013 pooled data study because it included new data from previous studies. I also included data from the Cramer

2016 pooled analysis and earlier publications with duplicative patients were not included. But I calculated the results both including and excluding these studies.

Exclusion

Studies were not included if they reported only crude ORs unadjusted for confounding factors. A few studies were excluded because, the research methods were poorly defined, even though they reported on women who frequently used talcum powder. Studies that asked participants a single question about ever use of talcum powder, without further quantification of exposure, were not included in the summary.

Defining Talcum Powder Products Use

Regular use was defined ideally as daily or at least more than 3 uses per week. I also accepted studies that defined use as “regular” where the description made it clear that this was regular use. Studies that reported “regular use” but defined it as use of less than this frequency, were not included. Regular use was selected to differentiate occasional use (which may include one-time or infrequent use or use during only a particular time of a woman’s menstrual cycle) from sustained regular use. Studies that asked participants a single question about ever use of talc, without further quantification of exposure, were not included in the summary. For example, Purdie reported that 52–57% of women reported ever using talc without further quantification and was not included. Several studies asked about *regular use* defined as at least once a month. These studies were not included unless they further characterized women into different categories of use; if so, I included data for women in the highest use category as long as this was group was large enough to be meaningful. When studies asked about ever use but defined use and stratified results by use, I included any data that may have reflected daily use. This measure of regular use is imprecise but is more accurate and meaningful than evaluating talcum powder exposure as any use.

Stratification of Analyses: Focus on a Single Histologic Type Where Possible

My review focused on invasive serous cancer where possible, but also included all invasive cancer. The decision to focus on a single histologic cancer type was in part because ovarian cancers include a broad range of types and association of talc and ovarian cancer might differ by type. I chose serous cancers because they are most common invasive ovarian cancer type. Importantly, serous ovarian cancer is the only histologic type for which most individual research studies accumulated sufficient cases for valid statistical analysis. This cancer type also has the least uncertainty in pathological diagnosis (see Section III, Histologic Types). Further and most importantly, serous ovarian cancer is the most aggressive histologic type, so identifying causal factors is important. Finally, I focused on invasive cancer (as opposed to borderline cancer) because the risk of death from invasive serous tumors is far higher than for noninvasive types, with growing consensus that borderline tumors may not be malignant.

Type of Exposures

Studies were included if they reported on perineal exposure (rather than exposure through sanitary napkins, diaphragms, or condoms) as this is the most common exposure type and is

likely to reflect the most consistent exposure. I did not exclude studies if they reported combined use, as long as the exposure included perineal use.

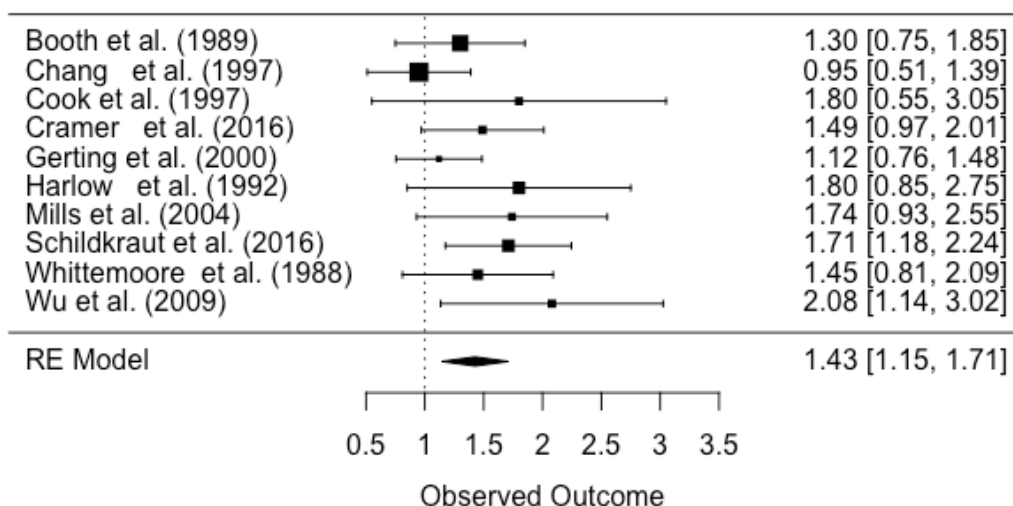
Statistical Analysis

Two individuals (Smith-Bindman and a consultant biostatistician) reviewed an abstracted data from each publication. Differences were resolved by consensus. The focus of the review was on quantifying the association between regular talcum powder products use and ovarian cancer, with a sub analysis on serous cancer and invasive cancer. Meta-analysis was performed using the metafor package in R (Version 3.5.1). The rma function was used to apply linear mixed effects models to study results and calculate summary statistics on effect size. Due to varying amounts and types of available data from each included publication, adjusted odds ratios (OR) and standard errors were used as the model inputs. Standard error (SE) was estimated using the relationship: 95% confidence interval = Effect size \pm 1.96*SE, assuming a roughly normal distribution of data and roughly symmetrical upper and lower confidence interval bounds. Incorporating adjusted ORs and SE into models in this way provides the added benefit of allowing model use of covariate-adjusted data (versus crude OR data). Weighting was done based on estimates of inverse variance. Study result heterogeneity was estimated based on maximum likelihood methods and was summarized via an I² statistic and associated p-value. The decision to include results from the cohort study by Gertig and colleagues (2000), which reported relative risk (RR), was based on the estimation that the RR value was only nominally different from the OR, a safe assumption in a study sample where less than 0.4% of the cohort developed the condition-of-interest.

Results

Overall 10 studies reported on daily talc powder products use and the risk of ovarian cancer. These studies were homogenous, and the odds of ovarian cancer associated with regular use was 1.43 (95% CI 1.15, 1.71). The included studies with associated point estimates are shown in a Forrest Plot in Figure 2

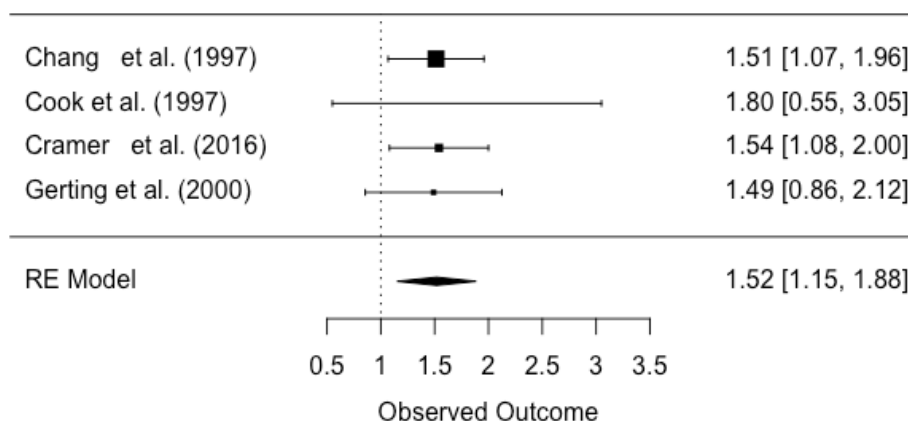
Figure 2. Forrest plot showing odds of ovarian cancer associated with regular use of talcum powder products.



The primary analysis of this excluded Terry, but the results were nearly identical if Terry was included

There were studies reported on regular talcum powder use and invasive serous cancer (or all invasive cancer if serous not reported) These studies were homogenous. The odds of invasive serous cancer associated with regular use was 1.52 (95% CI 1.15, 1.88). The results were similar when assessing the odds of all serous cancer.

Figure 3 Forrest plot showing odds of ovarian cancer associated with regular use of talcum powder products and invasive serous cancer.



New Systematic Meta-Analytic Review: Summary

The results of my systematic review of case-control studies on talcum powder use and ovarian cancer risk were consistent and indicate a **50% increase in risk of serous invasive cancer related to routine talcum powder exposure compared to no exposure**. This review had limitations including that study results were self-reported. I tried to be consistent in defining exposure, but this factor was subjectively determined by the individual studies. I tried to eliminate overlap of participant populations used in the included studies, but some patients may have contributed data to more than one study.

Overall Summary of the Epidemiology Data Describing the Association Between Talcum Powder Products and Serous Ovarian Cancer

I conclude, based on the review of the available primary studies, systematic reviews and my own quantitative review, that regular exposure to talcum powder products increases ovarian cancer risk by around 50%. The existing systematic reviews (in particular Penninkilampi and Berge) also concluded a significant increase in ovarian cancer risk following talcum powder exposure.

VII. Other Relevant Factors

Research Supporting Talcum Association with Ovarian Cancer: Transit to Ovary and Risk Reduction on Interruption

Evidence from relevant studies is clear that talcum powder particles applied to the genital region will ascend through the vagina and fallopian tubes and enter the pelvic cavity, reaching fallopian tubes and ovaries. In humans, this route has been established experimentally by labelling inert particles, applying them to the perineum just prior to planned hysterectomy, and then recovering them from the fallopian tubes following surgery. [Egli Fertil Stwriil 1961]

Further, talc particles have been found in normal and malignant ovarian tissue. Henderson found that in 10 of 13 tested epithelial ovarian cancer tumors, 75% had talc embedded in the tissue. This result confirms that talc reached to the areas with cancerous tissue, but not that it caused the cancer. Histological evaluation of ovaries removed because of ovarian cancer or benign conditions have identified both talc particles and asbestos fibers in the ovarian tissue, further supporting that particles applied to the perineum reach the ovaries.^{60,100} Heller found that in all women in a study who were having ovaries removed for benign ovarian growth had talc in their ovaries. These results confirm that talcum powder applied to the perineum may be absorbed into the vagina and migrate or be transported to the tubes and ovaries.¹⁰¹⁻¹⁰⁴ In 1967, Graham and Graham demonstrated that intraperitoneal application of asbestos in guinea pigs and rats results in overgrowth of ovarian epithelial cells comparable to the histologic changes in epithelial ovarian tumors in women. The greater frequency at which talc particles are discovered in ovarian cancerous tissue than in normal ovarian tissue further supports that these particles may be causing cancer.

Several epidemiological studies evaluated the risk of ovarian cancer associated with talcum powder products before and after women had tubal ligation or hysterectomy, which surgically removes the route by which talc reaches the ovaries. The studies strongly suggest that the increased risk of ovarian cancer associated with talcum powder products use is reduced or eliminated after tubal ligation or hysterectomy. The results support that the risk from talcum powder products is elevated when women have an open pathway from the perineum to the ovary that enables powder components to reach the ovaries via unobstructed fallopian tubes., The collective results demonstrate that talcum powder products are carcinogenic through direct transport/migration to the fallopian tubes and ovaries.

Variation in Risk when Talc Use is Discontinued

Several studies showed that the risk of ovarian cancer associated with talc powder products decreases as the time from discontinuation of powder use increases. For example, Cramer found an elevated risk of ovarian cancer with talc powder products use and the risk decreased as time since last use increased.⁷⁵

VIII. Consideration of Causality of Talc Powder Products and Ovarian Cancer : Bradford Hill Analysis

Causality is easiest to determine in studies such as randomized controlled trial, in which participants are randomized to receive or not receive a treatment, then their health is followed to see their response. However, people cannot ethically be randomized to be exposed to a potentially cancer-causing agent. Therefore, when assessing risk factors for cancer, the Bradford Hill Factors are often used. They provide a framework for assessing the weight of evidence to help decide if causality is likely, given a particular association, such as between talcum powder and ovarian cancer. The guidelines are imperfect and provide a framework as compared with an absolute set of criteria.

I address each of the Bradford Hill factors below, with my understanding of how the evidence of talcum powder products exposure supports or refutes causality. While the Bradford Hill Factors include nine aspects of association, they should not be used as a checklist for causation. Instead, they can help interpret associations and aid in inferring causality. For each factor, I have highlighted why I believe this factor is more or less important.

A) Strength of Association

It is frequently argued that the larger an apparent association, the more likely the association is to be real (causal) and important for epidemiological assessment. This would suggest that an OR of 2.0 is more likely to indicate causality and importance than an OR of 1.5. While this is often argued, I do not believe this is necessarily the case. If a risk factor increases the risk of disease by 50%, and the exposure is common, it will have a far greater impact on a number of people, in comparison to a rare exposure that has a higher associated OR. And if the association is truly one that increases risk by 50%, then this is the magnitude of the association that will be detected. It is not intuitive that if an exposure increases a risk by 50%, this difference is not discoverable compared with an exposure that increases risk by 100%. A larger association between exposure and disease may be easier to identify, but I do not believe it is more likely to indicate causality or importance.

As an example, Table 6 shows an overview of the relationship between bladder cancer and two of its known risk factors; occupational industrial chemicals and smoking. Several industrial chemicals such as 2-naphthylamine are strongly associated with bladder cancer risk. In 1954, Case et al. reported a 200-fold increased bladder cancer risk for workers exposed to 2-naphthylamine. In cohort studies of rubber industry workers, elevated standardized mortality ratios (SMRs) as high as 253 (95% CI 93, 551) were reported. Use of some of these chemicals are now prohibited in Europe and their use is regulated in the United States because they cause cancer.(OSHA, 2011).

Cigarette smoking is also a known bladder cancer risk factor. However, the RR for smoking and bladder cancer is around 3, and therefore about 100 times lower than the RR for exposure to industrial chemicals. Yet bladder cancer is the second most common cancer attributed to smoking in the United States. It impacts a very large number of individuals. Of the 70,000 cases of bladder cancer diagnosed each year, as many as 60% are estimated as attributable to smoking.

Using the RR magnitude to quantify the “importance” of these two risk factors, industrial chemicals and smoking, would be misleading. Smoking will result in far more cancers than industrial chemicals, even though the RR is much lower. In the crude data in Table 6, of the approximately 70,000 bladder cancers diagnosed annually in the United States, 50,000 are thought to result from cigarettes while fewer than 1000 result from occupational exposures. A 50% reduction in smoking exposure will save 25,000 men from getting bladder cancer. Reducing industrial chemical exposures will saving around 500 men from getting bladder cancer. Thus, any impact on reducing known exposures for bladder cancer has the potential to be around 50 times more impactful if directed at smoking.

Table 6. An example showing the number of individuals who might be impacted through exposure to an occupational chemical that leads to bladder cancer as opposed to smoking.

	Occupational Exposure	
	2-naphthylamine	Smoking
Estimated odds ratio associated with exposure	200	3
Number of individuals exposed annually	10,000	50,000,000
Bladder cancers due to exposure annually	1000	50,000
Impact on number of cancers diagnosed annual if exposure reduced by 50%	500	25,000

The bladder cancer example highlights that a factor that increases risk by 50% will have an enormous impact on population mortality if the exposure is common or if the cancer is particularly lethal. This is certainly the case for talcum powder products, which are used by as many as half of all women in the U.S. Women’s use of talcum powder products is so widespread that even a relatively modest increase in risk would pose a sizeable health risk to the population. Further, a 50% risk increase is particularly important for ovarian cancer, which has a high mortality rate, with rare early detection.

Defining a “strong” association is critical for assessing potentially causal relationships. A current concept in epidemiology is that considerations about whether a factor causes a disease should weigh statistical validity and significance and the multiple factors that influence the disease. Thus, assessing *strength of association* when inferring causality requires examining underlying research and analytic methods, comparing the weight of evidence in the literature, and considering other contextual factors. The data supporting the causality of talcum powder products exposure for ovarian cancer is extremely strong.

Using the existing evidence, I reviewed and assembled for this report, I estimated how many ovarian cancers that occur each year in the United States are likely to be caused by exposure to talcum powder products in comparison to other risk factors for ovarian cancer, Table 7. This is a relatively simple analysis, but nonetheless is informative. The total number of ovarian cancers that are estimated to occur in the US annually is 22,240, and these will occur among

the 50.8 percent of the U.S. population of 311 million who are women. Of these ovarian cancer cases, approximately half (11,120) will reflect invasive serous carcinoma. For the purpose of this simple analysis, I have assumed that the elevation in ovarian cancer risk associated with talcum powder product exposures occurs only with invasive serous carcinoma. This is not true, but the data are the most certain for these cancer and this is a conservative assumption (meaning the true number of cancer and proportion of cancers caused by talcum powder product users will be even higher than my calculation). A proportion of ovarian cancers will occur among women who regularly use talcum powder products, and the remainder will occur in women who do not regularly use talcum powder products. If we estimate that women who use talcum powder products regularly have a 50% elevated risk of invasive serious cancer and we estimate the number of women who are exposed to daily talcum powder products is between 10% and 30% (this proportion is fewer than ever users of talcum powder products), then between 1,589 and 4,351 women will be diagnosed each year with invasive serous cancer caused by the exposures, reflecting between 14% and 39% of all invasive serous cancers and reflecting between 7% - 20% of all ovarian cancer diagnosed each year. This is a tremendous risk. This is a very large number of cancers to be caused by a product that provides no medical benefit. This Bradford Hill Factor of the Strength of the association is important and is met.

Table 7 An estimate of the number of ovarian cancers and invasive serous cancers caused by regular use of perineal talc powder products.

Proportion of women who regularly use Talcum powder products	Annual Invasive Serous Cancer in Women Exposed to Talcum Powder Products	Annual Invasive Serous Cancer in Women Not Exposed to Talcum Powder Products	% Invasive Serous Cancer in Women Exposed to Talcum Powder Products	% of all ovarian Cancer in Women Exposed to Talcum Powder Products
10%	1,589	9,531	0.14	0.07
20%	3,033	8,087	0.27	0.14
30%	4,351	6,769	0.39	0.20

B) Consistency of Associations in Different Populations and Studies

Another consideration for association and causality is consistency of the data. The data on the association between genital talc and ovarian cancer are highly consistent. The relative stability in the estimated increase in the risk of ovarian cancer associated with talc powder products use (50% increase for regular users of talcum powder and serous cancers; around 40% increase for all epithelial ovarian cancer and regular users of talcum powder products), as assessed across time and in diverse populations with diverse study designs, strongly argues that the causal association is real and satisfies the Bradford Hill guideline for consistency of associations across populations and studies.

C) Specificity Between Cause and Effect

The Bradford Hill factors suggest that associations are more likely to be causal when an exposure causes only one disease. While some examples of highly specific exposures and outcomes exist, many exposures and health concerns involve complex chemical mixtures and low-dose environmental and occupational exposures complicated by a variety of personal risk factors. A recent review stated, "The original criterion of *specificity* is widely considered weak or irrelevant from an epidemiologic standpoint."¹⁰⁵ Asbestos, for example, is associated with a range of cancers and various exposures. Regardless of doubts about the meaningfulness of this factor, talcum powder products are primarily associated with ovarian cancer and thus fulfills the specificity consideration, although this consideration is not one of the most important considerations for causality in my expert opinion.

D) Temporality

An exposure must come before an outcome for the exposure to be causal. Bradford Hill explained that for an exposure-disease relationship to be causal, exposure must precede the onset of disease. While this is self-evident, in epidemiological studies, reverse causality, in which behavior related to a health issue is influenced by knowledge or events about the issue, is always a concern. For example, women who undergo ovarian cancer treatment may begin using talcum powder products during their pre- and post-operative period because of symptoms or side effects perceived to be alleviated by talcum powder products use. Assessing talcum powder use without specifying the time of use might lead to women with ovarian cancer being more likely to report talcum powder products use. In this example, talcum powder may not have caused the cancer; rather, use of talcum powder products was caused by the cancer (and treatments). The importance of this issue led to Bradford Hill's consideration of temporality when assessing causality.

In essentially all of the case-control studies that assessed use of talcum powder products, women were specifically asked to report talc powder products only during past, not current periods; thus, the studies explicitly assessed exposure to talcum before cancer. Typically, questions were phrased "Did you ever use talc, but not in the last year before cancer diagnosis?" to exclude the year prior to diagnosis. This issue is not relevant for the included cohort studies, as women were surveyed about their exposures prior to cancer ascertainment. Thus, the temporality consideration is important for my consideration and is satisfied.

E) Dose Response

In general, when risks are proportional to exposure (e.g., doubling exposure doubles risk) this dose-response evidence is considered to support causality. Many of the reviewed studies did not collect sufficient data to carefully quantify the dose response, and many limited their comparisons to an ever/never comparison. This is in part what motivated me to complete my separate quantitative review to at least be able to dis-entangle ever into regular versus not regular use. The reviewed studies that did provide data that could be used to assess the

potential for dose response had mixed results in quantifying dose response. While most studies showed evidence of a dose response, others did not. For example, Schildkraut showed that >20 years of any genital powder use (OR 1.51, 95% CI 1.11, 2.06) showed a stronger association with ovarian cancer than <20 years of use (OR 1.33, 95% CI 0.95, 1.86).⁹⁹ Terry and Harlow showed significant dose responses, where ORs increased as exposures increased.^{69,74} The adjusted ORs increased from 1.3, to 1.5 to 1.8 with <1000, 1000–10,000, and >10,000 lifetime applications. Overall, any exposure to talcum powder resulted in an OR of 1.5; direct perineal application had an OR of 1.7 (95% CI 1.1, 2.7), daily exposure had an OR of 1.8 (95% CI 1.1, 3.0) and women with an intact genital tract who were estimated to have had more than 10,000 applications during ovulating years had the highest risk (OR 2.8 95% CI 1.4, 5.4). This exposure was found in 14% of women with ovarian cancer. Penninkilampi⁶⁷, the most comprehensive of the systematic reviews, also showed a dose response where women with more than 3600 lifetime applications had slightly higher risks as did women who reported long-term (>10 years) talc use. In contrast, Whittemore⁷⁷ showed no dose response, and Booth⁷⁸ demonstrated the reverse—the higher the dose, the lower the risks. The data from reviewed studies were too diverse to summarize a dose-response relationship. The measures of exposure frequency and duration varied, and the studies used different thresholds for quantifying exposures. Further, the measures to quantify dose tended to be crude, making the response even more difficult to establish.

In summary, most but not all studies of talcum powder products and ovarian cancer show a dose response, but the results are inconsistent, and more importantly, are not considered or assessed in most of the published studies. A dose-response relationship is not required for causality and in large part because data were not consistently available, this factor does not weight heavily in my consideration. Further, this factor did not weight heavily in my considerations in that not all exposures will have a dose response, and some will indeed have a threshold effect. This is important here because asbestos is believed to exhibit a threshold, rather than a linear, dose-response.

F) Biologic Plausibility: Factors Linking Talc and Ovarian Cancer

The epidemiological evidence suggests a strong and positive association between exposure to talcum powder products and invasive ovarian cancer. However, epidemiological evidence alone does not provide a mechanism or pathophysiological process that accounts for the increased risk. Nor does the epidemiological evidence confirm the specific component or ingredient in talc powder products that is responsible for carcinogenesis. Nonetheless, the data are persuasive that particles contained in talcum powder reach the tubes and ovaries, inflammation initiate a causal pathway, and that several components of talc powder products including asbestos, asbestiform fibers in talc, and heavy metals can contribute to the carcinogenicity of the products. This was a strong factor in my consideration of the evidence because there is extremely strong evidence that the components of talc powder products are known to be highly carcinogenic in other settings.

G) Coherence and Consistency with Understood Biology

The guideline of coherence is considered similar to biological plausibility. For both, the cause-and-effect explanation should be consistent with all knowledge available. For talcum powder and ovarian cancer, this consideration is easily satisfied.

H) Experimental Evidence

The evidence in humans of the impact of talcum powder products exposure and ovarian cancer development is based on a large number of observational studies. Direct experimental evidence in the form of randomized controlled trials in humans is simply not possible to generate, for ethical reasons. The experimental evidence in humans that talc particles can migrate to the ovary and be incorporated into ovarian tissue is relevant to developing a causal model but does not directly prove that that exposure causes cancer. There is also human data relating to the inflammatory nature of ovarian cancer. There is compelling in vitro research delineating the inflammatory mechanism by which talcum powder causes cancer. Animal studies showing inflammatory tissue effects and tumor formation with talcum powder exposure are also supportive.

I) Analogy

Bradford Hill implied that when evidence is strong of a causal relationship between a risk factor and disease, researchers should be more accepting of weaker evidence that a similar risk factor may cause a similar disease. Thus, analogy has been interpreted to mean that when one causal agent is known, the standards of evidence are lowered for a second causal agent that is similar. The strong evidence for the association between asbestos and lung cancer, and the chemical similarity between these minerals, as well as their fibrous nature, supports the analogy consideration and causal inference.

Summary: Consideration of Causality of Talc Powder Products and Ovarian Cancer using Bradford Hill

In consideration of Bradford Hill, the clear strength of the association (A), remarkable consistency in the published literature across a large number of populations and research studies (B), temporality (D) considered in all of the published studies, and perhaps most importantly, biological plausibility (F) were the criteria that I considered of paramount importance when assessing the causality of exposures of talc powder products and epithelial ovarian cancer

IX. Conclusion

In conclusion, substantial evidence supports a strong, positive and causal association between ovarian cancer and genital exposure to talcum powder products. Regular exposure to talcum powder products causes ovarian cancer in some women. This opinion is based on my extensive review of the medical and scientific literature, my own independent meta-analysis of the data, and my experience and expertise in the areas of epidemiology and women's health, including ovarian cancer.

All opinions are made to a reasonable degree of medical and scientific certainty. I reserve the right to amend or supplement this report as new information becomes available.

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102. Sjosten AC, Ellis H, Edelstam GA. Retrograde migration of glove powder in the human female genital tract. *Human reproduction (Oxford, England)*. 2004;19(4):991-995.
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Exhibit A

CURRICULUM VITAE
REBECCA SMITH-BINDMAN, MD

Title Professor, Radiology and Biomedical Imaging, Epidemiology and Biostatistics,
Obstetrics, Gynecology and Reproductive Sciences, Phillip R. Lee Institute for Health Policy
Director, Radiology Outcomes Research Lab, University of California San Francisco

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350 Parnassus Ave, Suite 307
San Francisco, CA 94117
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EDUCATION

1980 - 1985	Princeton University	BSE	Engineering / Architecture
1985 - 1986	Columbia University		Post Bacc Pre-Med
1987 - 1991	University of California, San Francisco	MD	Medicine
1991 - 1992	University of California, San Francisco	Intern	Pathology
1992 - 1996	University of California, San Francisco	Resident	Radiology
1996 - 1997	University of California, San Francisco	Clinical Instructor	Radiology, Ultrasound
1996 - 1998	University of California, San Francisco	Fellow	Epidemiology & Biostatistics

LICENSES, CERTIFICATION

1992	California Medical License # G76462
1993	California X-ray Supervisor and Operator License RHL 143658
1996	Board Certification, American Board of Radiology

PRINCIPAL POSITIONS HELD

1998 - 2003	UCSF, Radiology and Biomedical Imaging, Epidemiology and Biostatistics, Obstetrics, Gynecology and Reproductive Sciences	Assistant Professor
2003 - 2009	UCSF, Radiology and Biomedical Imaging, Epidemiology and Biostatistics, Obstetrics, Gynecology and Reproductive Sciences	Associate Professor
2009 - current	UCSF, Radiology and Biomedical Imaging, Epidemiology and Biostatistics, Obstetrics, Gynecology and Reproductive Sciences	Professor
2014 - current	UCSF, Phillip R. Lee Institute for Health Policy Studies	Member
2000 - current	UCSF, Radiology Outcomes Research Lab	Director

OTHER POSITIONS HELD CONCURRENTLY

1999 - 2000	St Bartholomew's and The Royal London School of Medicine	Research Fellow
2009 - 2010	NIH, National Cancer Institute, Radiation Epidemiology Branch	Research Scientist

HONORS AND AWARDS

1985	Cum laude, Princeton University
1985	Senior Thesis Prize, Princeton University
1991	Student Summer Research Fellowship, Institute for Health Policy Studies, UCSF
1999, 2000	Nycomed Amersham Fellow, Radiologic Society of North America
2007	Nomination, Clinical Research Mentor of the Year, Bay Area Symposium on Clinical Research
2010	Nomination, CTSI Consultant of the Year, Impact Award
2010	Scientific Paper of the Year, Minnies, Auntminnie.com
2010	Finalist, Most Influential Radiology Researcher, Minnies, Auntminnie.com
2011	Leader in Imaging, Auntminnie.com
2012	Finalist, Scientific Paper of the Year, Auntminnie.com, Minnies
2012	Semifinalist, Scientific Paper of the Year, Auntminnie.com, Minnies
2012	Winner, UCSF Center for Health Care Value, Medical Center Initiative, Innovation Award
2013	Finalist, Scientific Paper of the Year, Auntminnie.com, Minnies
2013	Runner-up, Scientific Paper of the Year, Auntminnie.com, Minnies
2013	Paper honored as 1 of the top 10 publications Funded by NCI's Epidemiology and Genomics Research Program
2014	Invited Editor, J of the American College of Radiology, March 2014, Radiation Dose Optimization
2014	Among Philip R. Lee Institute for Health Policy Studies faculty videos on UCTV, "Is Medical Imaging Harmful to Health: Opportunities to Influence Health Policy", most popular, N = 409,937
2015	Academy of Radiology Research, Distinguished Investigator Award
2015	Election to Fellowship, Society of Radiologists in Ultrasound

KEYWORDS AND AREAS OF INTEREST

Health Services Research, Outcomes Research, Disparities Research, Women's Imaging, Comparative Effectiveness Research, Quality Improvement, Dissemination and Implementation Sciences, Evidenced Based Radiology, Assessment of Population Impact of Screening Tests, Radiation Associated with Medical Imaging, Radiation as an Environmental Cause of Cancer, Management of Incidental Findings on Diagnostic Testing

OVERVIEW

Narrative

Dr. Smith-Bindman is a clinical researcher with expertise in health services research, epidemiology, outcomes research, comparative effectiveness research, and dissemination and implementation sciences focused on diagnostic imaging. Her research has focused on evaluating the quality, utilization, accuracy, predictive values and impact of diagnostic testing on patient health, and has quantified both the risks and benefits of medical imaging when used in different contexts and by different populations. One area of focus has been on evaluating racial and ethnic differences in access and utilization of screening mammography and how that contributes to higher breast cancer mortality among African American women, and on factors that influence the quality and access to screening among vulnerable populations (see references 33, 34, 37, 43, 46, 48, 61, 67 at the end of CV). A separate area of focus has been on quantified the variation in radiation dose associated with medical imaging across patients and institutions, and quantified the impact of radiation, particularly from computed tomography, as an environmental carcinogen. (see references 53, 58, 60, 62, 65, 68, 69, 72, 76, 78, 79., 81, 87, 89, 91, 97, 102, 107.) Separate from her research activities, she has been actively involved in translating evidence into changes in practice and policy. She has *informed policy leaders, practitioners and the public about* the safety concerns surrounding the use of radiation in imaging by describing the issue in main stream media, testifying before the US Congress, and by advising the FDA, The Joint Commission, the International Atomic Energy Agency, the International Council on Radiation Protection and leading professional societies. She has also written quality measures focused on radiation safety, and her work has resulted in organizations which monitor health care quality to adopt measures of diagnostic imaging safety.

Significant Publications

1. **Smith-Bindman** et al. Ultrasound vs Computed Tomography for Suspected Nephrolithiasis NEJM. 2014; 371:1100-10
2. Miglioretti DL, Johnson E, William SA, Grenlee RT, Weinmann S, Solberg LI, Feigelson HS, Roblin D, Flynn MJ, Vanneman N, **Smith-Bindman R**. The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. JAMA Pediatr. 2013 167 (88): 700-7
3. **Smith-Bindman R**, et al. Risk of Thyroid Cancer based on Thyroid Ultrasound Imaging Characteristic: Result of A Population Based-Study. JAMA Internal Medicine. 2013 173(19):1788-96
4. **Smith-Bindman R**. Appendix F. Ionizing Radiation Exposure to the US Population, with a Focus on Radiation from Medical Imaging, included in Breast and the Environment: A Life Course Approach. The Institute of Medicine. March 20 2012
5. **Smith-Bindman R et al**. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. JAMA Internal Medicine 2009;169(22):2078-86
6. Curtis E, Quale C, Haggstrom D, **Smith-Bindman R**. Racial and Ethnic Differences in Breast Cancer Survival: How Much Is Explained By Screening, Tumor Severity, Biology, Treatment, and Co-morbidities. Cancer 2008 112(1):171
7. Goldman L, Haneuse S, Miglioretti D, Kerlikoswke K, Buist D, Yankaskas B, **Smith-Bindman R**, An assessment of the quality of mammography care at facilities treating medically vulnerable populations Medical Care 2008 46(7):701-8.
8. **Smith-Bindman et al**. Does Utilization of Screening Mammography Explain Racial and Ethnic Differences in Breast Cancer? Ann Intern Med. 2006; 144(8):541-53
9. Haggstrom DA, Quale C, **Smith-Bindman R**. Differences in the Quality of Breast Cancer Care Among Vulnerable Populations. Cancer. 2005 Dec 1;104(11):2347-58.
10. **Smith-Bindman, R**, et al Endovaginal ultrasound to evaluate endometrial abnormalities. JAMA 1999;281:1693-4

PROFESSIONAL ACTIVITIES

CLINICAL

Attending physician, Ultrasound Section, Department of Radiology and Biomedical Imaging, UCSF, 25%. Includes supervised instruction of residents and fellows. My teaching focuses on how to use evidence to help inform interpretation of clinical examinations.

PROFESSIONAL ORGANIZATIONS

Memberships

1997 - 2018	Society of Radiologists in Ultrasound (SRU)
1997 - 2018	Radiology Alliance for Health Services Research in Radiology (RAHSR)
2013 - 2018	American College of Radiology (ACR)
2014 - 2018	American Roentgen Ray Society (ARRS)
2014 - 2018	Association of University Radiologists (AUR)

Service to Professional Organizations (selected)

2010 - 2011	American Board of Medical Specialties, American Board of Radiology, American College of Radiology, and Physician Consortium for Performance Improvements. Patient Radiation Dose Work Group
2011 - 2012	Institute of Medicine Committee on Breast Cancer and the Environment, commissioned report "Temporal Changes in Ionizing Radiation and Estimate of Contributions to Breast Cancer," contributing author
2012	Centers for Disease Control and Prevention, Cancer Prevention Work Group
2012 - 2014	The Joint Commission, Diagnostic Ionizing Radiation and Magnetic Resonance work group focused on issues of safety and guideline development
2012 - Present	International Council on Radiation Protection (ICRP) Task Group #79 on Defining Effective Dose Use in Medicine
2014	International Atomic Energy Agency (IAEA) United Nations General Assembly and Security Council. Special Committee Considering Population Impact of Low Dose Radiation
2015	Council of Distinguished Investigators of the Academy of Radiology Research

Service to Professional Publications (selected)

2000 - 2018	Journal of the American Medical Association (JAMA)
2000 - 2018	JAMA Internal Medicine
2000 - 2018	New England Journal of Medicine (NEJM)
2000 - 2018	Radiology
2000 - 2018	American Journal of Radiology
2000 - 2011	Journal of the National Cancer Institute
2000 - 2011	Health Affairs

2000 - 2015	Health Services Research
2000 - 2010	American Journal of Obstetrics & Gynecology
2000 - 2010	American Journal of Public Health
2000 - 2010	Annals of Internal Medicine
2000 - 2010	Journal of Medical Screening
2000 - 2010	Journal of Women's Health
2000 - 2010	Medical Care
2000 - 2010	Medical Decision Making
2000 - 2010	Obstetrics and Gynecology
2000 - 2010	Ultrasound in Obstetrics & Gynecology

INVITED PRESENTATIONS

International

2001	US - UK Cancer Learning Network, Deprivation and Cancer, <i>London, United Kingdom</i>
2001	British Society of Human Genetics, Prenatal Screening for Down syndrome in England and Wales and Birth Outcomes, <i>London, United Kingdom</i>
2002	Global Summit on Mammographic Screening, Europe Institute of Oncology, U.S.-U.K. Comparison of Screening Mammography, <i>Milan, Italy</i>
2005	University of Copenhagen, Does Practice Make Perfect; Association Between Volume and Accuracy of Mammography, <i>Copenhagen, Denmark</i>
2006	International Society for Prenatal Diagnosis, Prenatal Screening for Down syndrome in The Second Trimester of Pregnancy, <i>Kyoto, Japan</i>
2009	Canadian Breast Cancer Foundation, Forum on the Earlier Detection and Diagnosis of Breast Cancer, <i>Toronto, Canada</i>
2010	Nation Cancer Research Institute (NCRI), Risk of Cancer from Computed Tomography Examinations, <i>Liverpool, United Kingdom</i>
2013	Bach Mai University Hospital, Radiation for Medical Imaging: A Hidden Epidemic, <i>Hanoi, Vietnam</i>
2014	International Atomic Energy Agency (IAEA), Health Effects of Exposure to Low Dose Ionizing Radiation Associated with Medical Imaging, <i>Vienna, Austria</i>
2014	Korea College of Radiology, Tracking and Monitoring Radiation Dose and Its Impact Across the University of California Medical Centers and CT Radiation Doses Are Not What You Think: Why It's Important to Monitor and Track Dose Seoul, Republic of Korea
2016	International Atomic Energy Agency (IAEA), Exposure to low dose ionizing radiation from medical imaging and the health effects from these exposures. International Atomic Energy Agency. Technical Meeting on Science, Technology and Society Perspectives on Nuclear Science, Radiation and Human Health: The View from Asia, Singapore University
2016	University of North Carolina School of Medicine, Chapill Hill, NC, Radiology Department Grand Rounds , Diagnostic Imaging: Increasing Effectiveness and Safety Radiation From Medical Imaging,

2016	Singapore General Hospital, Singapore. Radiology Grand Rounds. Visualizing Patients and Their Dose to Improve Health Care Quality,
2016	St Luke's International Hospital, Tokyo, Japan. Hospital-wide grand rounds, Radiation from Medical imaging: A Hidden Epidemic.
2017	Childhood Leukemia International Consortium, Annual Meeting, Minneapolis, Minnesota, Estimating Radiation Exposure from Imaging Procedures
2017	Charity Hospital, Berlin, Germany. Radiology Grand Rounds, Radiation from Medical Imaging: A Hidden Epidemic
2017	Charity Hospital, Berlin, Germany, Imaging for Suspected Nephrolithiasis: Results from the Randomized Controlled Trial
2017	University Hospital, Basel, Switzerland, Radiology Grand Rounds. A Dose of Reality: The Need for Active CT Dose Management
2017	Center for Diagnostic Imaging Quality Institute Council of Medical Directors, Scottsdale, AZ Keynote: Radiation from Medical Imaging
2017	The Leap Frog Group Pediatric Computed Tomography Radiation Dose
2017	PCORI Advisory Panel on Communication and Dissemination Research Presentation UCSF CT Radiation Dose Registry to Ensure a Patient-Centered Approach for Imaging
2017	American Urological Association (AUA) Quality Improvement Summit, Baltimore Maryland Keynote Address. Imaging Wisely: Improving the Value of Medical Imaging
2018	Jakarta Radiology Society, Jakarta Indonesia. Dose Optimization Implementation to achieve better radiology service in Hospital Keynote Addresses: Radiation from Medical Imaging: A Hidden Epidemic and Optimizing Radiation Doses for CT
2018	Westmead Hospital Sydney Australia. Radiology Grand Rounds. Radiation from Medical Imaging: A Hidden Epidemic
2018	Westmead Childrens Hospital, Sydney Australia. Optiizing Radiation Doses For Pediatric CT
<u>National</u>	
2000	American College of Medical Genetics
2000	Society of Radiologists in Ultrasound
2000	Society for Health Services Research in Radiology
2001	Society of Radiologists in Ultrasound Annual Meeting

2001	Society for Health Services Research in Radiology
2002	Society of Radiologists in Ultrasound
2003	Breast Cancer Surveillance Consortium
2003	Society of Radiologists in Ultrasound
2003	Centers for Disease Control and Prevention
2003	RSNA 88th Scientific Assembly and Annual Meeting
2004	Institute of Medicine (IOM): Saving Women's Lives
2004	Breast Cancer Surveillance Consortium
2005	Improving Mammographic Quality Standards Institute of Medicine (IOM)
2006	Beth Israel Deaconess Medical Center, Grand Rounds
2006	National Institute Child Health and Human Development
2007	National Cancer Institute, National Institute of Health (x2)
2008	Mount Sinai Urban Health Institute; Metro Chicago Breast Cancer Taskforce, Partnerships in Translation: Advancing Research and Clinical Care
2008	University of Washington, Seattle, Washington, Grand Rounds, and Visiting Professor,
2008	HMO Research Network Conference (4 th annual), Danville, Pennsylvania
2009	Society of Radiologists in Ultrasound, National Conference on Management of Ovarian Cysts
2009	Canadian Forum for the Earlier Detection and Diagnosis of Breast Cancer
2010	Center for Disease Control & Prevention, Annual Cancer Registry Meeting, Atlanta, Georgia
2010	HMO Research Network conference, Emerging Frontier in Healthcare, Research Delivery, Austin, Texas
2010	National Council on Radiation Protection (NCRP), Communication of Radiation Benefits and Risks in Decision Making
2010	National Cancer Institute, Board of Scientific Advisors, Bethesda, Maryland
2010	American Statistical Association Conference on Radiation Health, Annapolis, Maryland
2010	Breast Cancer Surveillance Consortium Annual Meeting, Washington, D.C.
2010	Kaiser Permanente: National Radiology Leadership Group, held at the RSNA, Chicago, IL
2011	Cleveland Clinic, Health Care Quality Innovation, Cleveland, Ohio
2011	Auntminnie.com, Live WebEx Conference RADEXPO 2011
2011	University of New Mexico, Visiting Professor, External Reviewer, Resident Research Day
2011	Oregon Health Sciences University, Department of Emergency Medicine, Grand Rounds
2012	Society for Imaging Informatics for Medicine (SIIM), San Francisco, CA
2012	Brown University, Grand Rounds, Emergency Medicine, RI Hospital, Providence, RI
2012	Society for Imaging Informatics in Medicine (SIIM), Los Angeles, CA

2012 PharmMed OUT, Georgetown University, Washington, DC

2012 Agency for Healthcare Research and Quality, Rockville, MD

2012 Radiology Society of North America, expert witness in full day mock trial focused on radiation safety and whether radiologists need to communicate risks to patients, Chicago, IL

2012 University of Pennsylvania, Grand Rounds, Emergency Medicine, Philadelphia, PA

2013 Radiology Society of North America (RSNA), Controversies Session, CT Radiation and Risk: How Certain Are We of the Uncertainty? Chicago, IL

2013 American Cancer Society, Doc Talk Lecture Series

2013 Association of University Radiologists (AUR), Comparative Effectiveness and Patient-centered Outcomes Research, Los Angeles, CA

2014 Cancer.net Podcast, "CT Scans and Cancer Risk", Available Online at <http://www.cancer.net/blog/2014-10/ct-scans-and-cancer-risk>

2014 Oregon Chapter, American College of Emergency Physicians, Portland, Oregon

2015 Women in Government Foundation (non-profit, non-partisan organization of all U.S. female state legislators) Diagnostic Imaging. Increasing Its Effectiveness and Safety, at 16th Annual Southern & Eastern Regional Conference, Charleston S Carolina

2016 Lindeberger Cancer Center, University of North Carolina, Chappil Hill NC, Radiation From Medical Imaging: A Hidden Epidemic

2017 American Urological Association (AUA) Quality Improvement Summit, Baltimore Maryland Keynote Address. Imaging Wisely: Improving the Value of Medical Imaging

Regional Presentations (selected)

2000 Kaiser Permanente Department of Genetics, Oakland CA

2001 San Francisco State University, SF CA

2001 UCSF, San Francisco General Hospital, Department of Medicine, Grand Rounds

2001 American College of Obstetrics and Gynecology

2002 UCSF Breast Oncology Program Comprehensive Cancer Center Grand Rounds

2003 UCSF Obstetrics and Gynecology Grand Rounds, SF CA

2004 UCSF Multi-Department Symposium. Racial Disparity and Breast Cancer, SF CA

2004 UCSF Quality of Breast Cancer Care Symposium, SF CA

2005 Sisters Network, San Francisco (African American Advocacy Organization)

2005 Stanford University, Department of Health Research and Policy, Grand Rounds, Palo Alto CA

2006 UCSF, Lunch and Learn: San Francisco Community Outreach, SF CA

2006 Bay Area Health Care and Quality Outcomes, San Francisco, CA

2007 California Breast Cancer Research Symposium, Los Angeles, CA

2010 Bay Area Clinical Research Symposium, Plenary Speaker, San Francisco CA

2011	UCSF Department of Medicine Grand Rounds, San Francisco, CA
2011	San Francisco General Hospital Department of Medicine, Grand Rounds, San Francisco, CA
2011	UCSF, Department of Urology Grand Rounds, San Francisco, CA
2011	UCSF Department of Radiology Grand Rounds, San Francisco, CA
2011	Eden Hospital, Department of Medicine Grand Rounds, Alameda, CA
2011	Stanford Hospital, Department of Medicine, Grand Rounds, Palo Alto, CA
2011	Kaiser Permanente Medical Center, Multi-departmental Grand Rounds, San Francisco, CA
2011	UCSF Institute for Health Policy Studies, San Francisco, CA.
2012	Kaiser Permanente Medical Center, Grand Rounds, San Francisco, CA
2012	Kaiser Permanente Medical Center, Grand Rounds, Oakland, CA
2012	Massachusetts General Hospital, Department of Emergency Medicine, Grand Rounds Boston,
2012	Beth Israel Hospital, Department of Emergency Medicine Grand Rounds, Boston, MA
2012	Univ. of California Office of the President, Quality Improvement and Technology, Oakland, CA
2012	UCSF, Department of Radiation Oncology, Grand Rounds,
2012	Southern California Kaiser Radiology Chiefs Grand Rounds,
2014	UCSF, Endocrine Grand Rounds, San Francisco, CA
2015	California Society of Radiology Technologists, Annual Meeting, San Francisco, CA Keynote Address. Radiation from CT: A Hidden Epidemic. Strategies to minimize doses: What technologists can do?
2016	Society of Radiology in Ultrasound, Annual Meeting, Baltimore Maryland. Risk of Thyroid Cancer Based on Thyroid Ultrasound Imaging Characteristics
2016	UCSF, Breast Oncology Program, Radiation from Medical Imaging: A Hidden Epidemic and Approaches for Improving.
2016	UCSF Mini-Medical School Radiation Safety and Medical Imaging
2017	University of California Davis, Radiology Grand Rounds, Radiation from Medical Imaging; A Hidden Epidemic
2017	UCSF: Stand Up for Science: Panel Discussant

GOVERNMENT AND OTHER PROFESSIONAL SERVICE (selected)

2002 - 2003	CDC, National Breast and Cervical Cancer Early Detection Program, Planning Committee
2002 - 2005	Cochrane Collaboration Screening and Diagnostic Tests, Methods Working Group
2003 - 2003	Radiology National Boards, Examination Question Writer
2003 - 2010	National Cancer Institute, Physician Data Query (PDQ)

2004 - 2005	CDC, National Breast and Cervical Cancer Early Detection Program, Panelist, Committee on Assessment of Covered Benefits, Expert
2007 - 2010	California Health Benefits Review Program (CHBRP)
2008 - 2011	Center for Scientific Review, NIH, Health Services Organization and Delivery Study Section
2010 - 2011	American Board of Medical Specialties, American Board of Radiology, American College of Radiology, and Physician Consortium for Performance Improvements. Patient Radiation Dose Work Group
2010	Congressional Hearing, US House of Representatives, Energy and Commerce, Subcommittee on Health. Medical Radiation: An Overview of the Issues. Expert Witness
2010	Food and Drug Administration, Center for Devices & Radiological Health, National Meeting Focus on Radiation Safety, Presenter
2010 - 2011	National Quality Forum, Imaging Efficiently Steering Committee
2011 - 2012	Institute of Medicine Committee on Breast Cancer and the Environment, commissioned report "Temporal Changes in Ionizing Radiation and Estimate of Contributions to Breast Cancer," contributing author
2010 - 2011	Lung Cancer Screening with CT Evidence Review Committee. Multidisciplinary collaboration, including American Cancer Society, American College of Chest Physicians; American Society of Clinical Oncology & The National Comprehensive Cancer Network
2011 - 2016	International Council on Radiation Protection (ICRP), Task Group 79 on Defining Effective Dose Use in Medicine
2012	Congressional Hearing, US House of Representatives, Energy and Commerce, Subcommittee on Health, hearing on the Consistency, Accuracy, Responsibility, and Excellence in Medical Imaging and Radiation Therapy (The CARE Bill), Expert Witness
2012	Centers for Disease Control and Prevention, Cancer Prevention Work Group
2012 - 2014	The Joint Commission, Diagnostic Ionizing Radiation and Magnetic Resonance work group focused on issues of safety and guideline development
2013	Government Accountability Office: Medicare Imaging Accreditation Establishing Minimum National Standards and an Oversight Framework to Ensure Quality and Safety of Advanced Diagnostic Imaging Services, May 2013, Contributor
2014	International Atomic Energy Agency (IAEA) United Nations General Assembly and Security Council. Special Committee Considering Impact of Low Dose Radiation
2015	Council of Distinguished Investigators of the Academy of Radiology Research

UNIVERSITY AND PUBLIC SERVICE

Service Narrative

There are several activities to which Dr. Smith-Bindman has contributed. For seven years she participated in the NCI sponsored Physicians Data Query (PDQ), an NCI committee charged with presenting evidenced based, on-line, widely accessible and widely disseminated guidelines relating to cancer screening and diagnosis. She

participated in several activities related to breast cancer screening including acting as a reviewer for the CDC on assessing the guidelines for the National Breast and Cervical Cancer Detection Program, participating in coverage decisions, acting as reviewer and content expert for the CA Health Benefits Review Program analyzing several bills before the state legislature that would expand breast cancer screening to include MRI, and participating in the creation of several IOM Reports. She has participated in several community projects, such as acting on the board of an African American breast cancer advocacy group, and as a consultant to the Metropolitan Breast Cancer Task Force, charged with improving breast cancer mortality rates and racial disparities. During the last five years She has been very active in local, statewide and national efforts around improving radiation safety, including invited presentations to the FDA, testifying before the US Congress on two occasions, working with innumerable societies and government organizations on guidelines and submitting two endorsed quality measures on radiation safety to the National Quality Forum. Her involvement in service activities within the University have focused on increasing the quality and quantity of translational research through participation in several University-wide task forces. Dr. Smith-Bindman serves on several Medical Center Committees, focusing on improved oversight and stewardship around radiation, and projects to improve the efficiency and effectiveness with CT.

UNIVERSITY SERVICE (selected)

2001 - 2015	UCSF School of Medicine, Faculty Recruitment Committees, Radiology, Rad Onc, Medicine
2002	UCSF School of Medicine Dean's Leadership Retreat, Santa Cruz
2003	University of California, Blueprint for Regional Excellence in Breast Cancer Care
2003	UCSF School of Medicine Task Force, Future of UCSF and Mission Bay
2003	UCSF Medical Center, Hospital Exceptional Physician Award, Committee Co-Chair
2003 - 2004	UCSF School of Medicine Task Force, Physician Scientist Program Clinic-Based
2003 - 2005	UCSF School of Medicine Faculty Council
2005	UCSF School of Medicine, Dean's Leadership Retreat, Santa Cruz, CA
2005 - 2006	UCSF Department of Radiology Seminars and Presentation Committee
2005 - 2008	UCSF Department of Radiology Annual Research Symposium Abstract Review Committee
2005 - 2009	UCSF Department of Radiology, SEED Grant Review Committee
2006 - 2007	UCSF Pathways for Clinical and Translational Research
2008 - 2010	UCSF Pathways to Discovery, Clinical and Translational Research, Advisory Council
2007 - 2010	University of California, Office of the President, CA Health Benefits Review Program
2009 - 2017	UCSF, Radiation Safety Committee
2012 - 2014	UCSF Department of Radiology, Maintenance of Certification Committee
2012 - 2015	UCSF Medical Center, Center for Health Care Value
2013 - 2017	UCSF School of Medicine, Conflict of Interest Advisory Committee
2014 - 2016	UCSF Clinical Enterprise, Strategic Plan, Committee for Continuous Process Improvement
2015 - 2017	UCSF Clinical Enterprise, Utilization Management Committee

PUBLIC SERVICE

2003 – 2007	SF Sisters, an African American breast cancer advocacy group, board member
2008 - 2008	Metropolitan Chicago Breast Cancer Task Force, Chicago IL, unpaid consultant
2011 - 2014	National Quality Form, National Consensus Standard for Patient Safety. Measure Developer "UCSF CT Radiation Dose Patient Safety Measure" Measure endorsed
2015	National Quality Forum, Pediatric Measures. Measure Developer, "Pediatric Computed Tomography Radiation Dose" Measure endorsed

TEACHING AND MENTORING

Teaching Narrative

Dr. Smith-Bindman spends substantial time mentoring trainees in clinical research. The trainees have ranged in experience from high school students through mid-career UCSF faculty. The individuals have come from a broad range of departments at UCSF including Radiology, Internal Medicine, Hospital Medicine, Emergency Medicine, Obstetrics and Gynecology, and Urology, and have also come from the UCSF Medical School, The University of California Berkeley, and local SF high schools. On average, she meets with each trainee 1-2 hours per week while collaborating. An NIH Mid-Career Investigator Award (K24) supported her time mentoring these individuals.

She teaches in several formal classes in the department of Epidemiology and Biostatistics primarily targeted to post graduate students who are completing a master's degree in clinical research. She is actively engaged in teaching the Radiology residents and fellows while attending on the clinical service and provides frequent lectures to the Radiology residents focused at research methods; frequently teaches in courses organized by the UCSF Office of Continuing Medical Education for both radiology courses and courses within other medical specialties. The radiology courses focus on using evidence to interpret our studies (usually focused on ultrasound topics), the lectures for other medical specialties focused on how to use imaging more appropriately. As listed above, she also frequently gives grand rounds within UCSF, and nationally on using imaging more appropriately. Lastly, she organized and ran a large, ongoing, virtual symposium on Radiation Safety described below. Both the content and format of this meeting were novel.

TEACHING

Formal scheduled classes for UCSF students.

The first class listed is a course for UCSF Medical Students. The remaining are part of the coursework offered within the UCSF Masters in Clinical Research Program, Department of Epidemiology and Biostatistics

Year	Title	Role	Class Size
2002 - 2005	Epidemiology and Biostatistics, UCSF School of Med	Section Leader	20
2005	Introduction to Diagnostic Testing	Lecturer	18
2007 - 2008	Clinical Performance and Health Outcome Measurement	Lecturer	20
2011 - 2014	Translating Evidence into Policy: Theory and Design	Lecturer	30
2010 - 2015	Framing Research to Influence Policy	Lecturer	25

Post Graduate CME courses (1-5 lectures/meeting)

2001	UCSF Obstetrics and Gynecology Update, San Francisco, CA
2001	UCSF Primary Care Medicine, Aspen, CO
2001	Primary Care Medicine, Maui, HI
2001	Management of the Hospitalized Patient, San Francisco, CA
2001	Controversies in Women's Health, San Francisco, CA
2001	Diagnostic Imaging in Women's Health, San Francisco, CA
2001	MRI & Ultrasound Imaging, Lake Tahoe, CA
2002	Obstetrics and Gynecology Update, San Francisco, CA.
2002	17th Annual Primary Care Medicine: Concepts and Controversies, Aspen, CO
2002	10th Annual Controversies in Women's Health, San Francisco, CA
2002	Diagnostic Imaging in Women's Health, San Francisco, CA
2002	Diagnostic Imaging, Maui, HI
2002	Obstetrical, Gynecological and Abdominal Ultrasound, San Francisco, CA
2003	Primary Care Medicine, Diagnostic Imaging in Women's Health, Maui, HI
2003	11th Annual Controversies in Women's Health, San Francisco, CA
2003	Diagnostic Imaging for Disease Prevention, San Francisco, CA
2003	46th Annual Diagnostic Radiology Postgraduate Course, San Francisco, CA
2003	OB/GYN and Abdominal Ultrasound, San Francisco, CA
2003	MRI and Ultrasound by the Lake, Lake Tahoe, CA
2004	Women's Imaging, Sonoma, CA
2004	Primary Care Medicine, Maui, HI
2004	Diagnostic Imaging in Clinical Practice, San Francisco, CA
2005	Obstetrical and Gynecologic Sonography, San Francisco, CA
2005	Radiology Spring Training, Scottsdale, Arizona
2005	Abdominal Imaging, Montreal and Quebec, Canada
2006	Controversies in Women's Health, San Francisco, CA
2006	Controversies in Breast Cancer Screening and Diagnosis, San Francisco, CA
2006	Cutting Edge Radiology, Diagnosis and Intervention, Vancouver, Canada
2008	Primary Care Medicine: Update 2008, San Francisco, CA
2008	Diagnostic Imaging in Women's Health, San Francisco, CA
2008	Obstetrical/Gynecological and Abdominal Sonography, San Francisco, CA
2009	Primary Care Medicine: Update 2008, San Francisco, CA

2009	Obstetrical/Gynecological and Abdominal Sonography Update, San Francisco, CA
2011	Imaging of Kidney Stones, San Francisco, CA, Director
2011	Primary Care Medicine, Principles & Practice, San Francisco, CA, Keynote
2011	39th Annual Advances in Internal Department of Medicine, San Francisco, CA, Keynote
2011	Controversies in Women's Health, Department of Medicine, San Francisco, CA, Keynote
2012	Updates on Imaging, Maui, Hawaii
2013	UCSF Otolaryngology Annual Conference, San Francisco, CA
2017	UCSF Practical Body Imaging, Kona, Hawaii

Other Teaching

Radiation Safety and CT: Virtual Symposium. Innovative on-line Interactive CME course targeted to physicians (radiologists and those who order imaging), technologists, medical physicists, and trainees. This was created as an on-line, free, virtual meeting focuses on radiation safety. The initial creation of this virtual meeting began in 2013. Creating the meeting involved creating a multidisciplinary, on line, virtual meeting with over 100 lectures (see list of lectures, now offered freely on line - <http://rorl.ucsf.edu/speakers>), 10 live interactive sessions/chat rooms and over 500 registrants enrolled in the meeting during the “live days”, and ongoing attendees attend each month. The speakers at the meeting included numerous department chairs, the director of the Agency for Health Care Policy at the time, a US Congressman, leaders from numerous societies, The Joint Commission, The American Board of Internal Medicine Foundation, and innumerable scientific experts on diverse patient safety issues, and the meeting was an integration of diverse viewpoints and perspectives. Dr. Smith-Bindman directed this meeting and personally wrote and delivered 7 lectures for the meeting. The meeting was novel in format and content.

MENTORING

Pre-doctoral students directly supervised

Dates	Name	Program or School	Current Position
2004 - 2005	C. Kagay	UCSF Medical School	Radiologist, Private Practice
2005 - 2006	A. Ding	UCB/ UCSF MD/MPH	MGH
2005 - 2008	A. Venkatesan	UCSF Medical School	Resident, Stanford
2006 - 2007	E. Dinkelspiel	Urban High School	Student, Univ. of Chicago
2011 - 2015	J. Keegan	Lick Wilmerding High	San Luis Obispo College
2010 - 2015	P. Mehta	UC Berkeley/UCLA Med School	UCLA Medical School
2012 - 2013	J. Zhang	UC Berkeley	Senior
2014 summer	A. Fraser	University High	Georgetown College

Postdoctoral fellows and residents directly supervised

Dates	Name	Position	Current Position
1998 - 2000	M. Copanigro, MD	Radiology Resident / Fellow	Private Practice

1998 - 2000	N. Vincoff, MD	Radiology Resident / Fellow	Private Practice
2003 - 2004	E. Weiss, MD	OB GYN Resident	Private Practice
2003 - 2005	K. Schueler, MD	RORL Research Fellow	Private Practice
2003 - 2005	D. Haggstrom, MD	Internal Medicine Fellow	Indiana University, Faculty
2005 - 2006	K. Reid, MD	Internal Medicine Fellow	Emory Faculty
2005	A. Jensen	PhD student, Copenhagen	Faculty
2005 - 2006	B. Ching, MD	Radiology Fellow	Private Practice,
2005 - 2006	A. Cole, MD	Radiology Fellow	Private Practice
2005 - 2007	L. Goldman, MD	Internal Medicine Fellow	UCSF Faculty
2006 - 2010	J. Lipson, MD	Radiology T32 Scholar	Stanford Faculty
2007 - 2008	J Stengel, MD	Radiology Fellow	Private Practice
2007 - 2008	A. Heath, MD	RORL Research Fellow	Private Practice
2007 - 2009	R. Cho, MD	Radiology Fellow	Private Practice
2007 - 2009	D. Sellami, MD	Radiology Resident / Fellow	Private Practice
2008 - 2009	A. Kamath, MD	Radiology T32 Scholar	NYU Faculty
2009 - 2010	J Ching, MD	OB GYN Resident	Faculty
2009 - 2011	N, Brasic, MD	Radiology Fellow	UCSF Faculty
2010 - 2011	D. Sridhar, MD	Radiology Resident	Private Practice
2010 - 2012	P. Lebda, MD	Radiology Fellow	Cleveland Clinic Faculty
2010 - 2013	I. Burger, MD	Radiology Resident	Private Practice
2010 - 2013	G. Merry, MD	Radiology Resident	Private Practice
2011 - 2014	J. Mongan, MD PhD	Rad Resident / Fellow	UCSF, Faculty
2013 - 2014	S. Hou, MD	Radiology Resident	NYU Faculty
2013 - 2014	C. Lee, MD	Radiology Resident	UCSF Faculty
2013 - 2014	T. Morgan, MD	Radiology Resident	UCSF Faculty
2013 - 2015	LA Hampton, MD	Urology Resident / Fellow	Fellow, Wash U
2013 - 2015	V. Arasu, MD	Radiology Resident	Resident
2013 - 2015	N. Benedetti, MD	Radiology Resident	University of Wash Faculty
2014 - 2015	B Carpenter, MD	Radiology Fellow	UCSF Faculty
2014 - 2015	J. Hsu, MD	Radiology Fellow	Private Practice
2014 - 2018	J. Demb	Epidemiology	UCSF

Faculty Mentoring

Dates	Name	Department / Section	Current Position
2002 - 2005	John Shepherd, MD	Radiology / Musculoskeletal	UCSF, Faculty, Radiology
2004 - 2005	Elaina Curtis, MD	UCSF Visiting Fellow	Univer. of Auckland Faculty
2005 - 2006	John Stein, MD	Emergency Medicine	UCSF Faculty, Emerg Med
2005 - 2006	Max Wintermark, MD	Radiology / Neuro	UVA, Faculty, Radiology
2007 - 2013	Lauren Goldman, MD	Internal Medicine	UCSF, Faculty, Medicine
2008 - 2011	Larry Rand, MD	OBGYN / Maternal Medicine	UCSF, Faculty, OBGYN
2008 - 2014	Antonio Westphalen, MD	Radiology / Abdominal Imaging	UCSF, Faculty, Radiology
2009 - 2017	Liina Poder, MD	Radiology / Abdominal Imaging	UCSF, Faculty, Radiology
2010 - 2018	Ralph Wang, MD	Emergency Medicine	UCSF Faculty, Emerg Med
2014 - 2018	John Mongan, MD, PhD	Radiology / Abdominal Imaging	UCSF, Faculty, Radiology
2014 - 2017	Cindy Lee, MD	Radiology / Abdominal Imaging	UCSF, Faculty, Radiology
2014 - 2017	Tara Morgan, MD	Radiology / Abdominal Imaging	UCSF, Faculty, Radiology
2014 - 2018	Maureen Kohi, MD	Radiology / Interventional	UCSF, Faculty, Radiology
2015 - 2018	Ben Franc, MD PhD	Radiology / Nuclear Medicine	UCSF, Faculty, Radiology
2017 - 2018	Brian Haas MD	Radiology	UCSF, Faculty, Radiology

RESEARCH AND CREATIVE ACTIVITIES

Research Narrative

Dr. Smith-Bindman's research focuses on understanding the impact of diagnostic testing on patient outcomes. She is the director of the UCSF Radiology Outcomes Research Laboratory, and her team includes several programmers, biostatisticians, a developer, and a handful of epidemiologists who serve as project managers for the funded grants below. Her research expertise is in areas of epidemiology, technology assessment, outcomes research, comparative effectiveness research, health services research, and dissemination and implementation sciences focused on imaging. The research has focused on evaluating the quality, utilization, accuracy, predictive values and impact of diagnostic testing on patient health, and has quantified both the risks and benefits of medical imaging when used in different contexts and by different populations. I am leading several studies that assess and standardize the radiation dose used for CT scanning, in order to minimize doses, without loss of diagnostic accuracy. Additional current research is focused on putting systems-based solutions in place to standardize the use of imaging. For example, ongoing projects focus on improving decision support provided to physicians to help improve the use of testing, using evidence to drive and guide the change in practice, and determining the optimal surveillance strategy for the follow up of incidental findings seen on CT imaging. The research projects she leads, listed below, are typically collaborative, involving researchers from diverse clinical areas and who offer diverse methodological expertise.

RESEARCH AWARDS

Current

PI	07/02/2014 - 06/30/2019
NIH	\$1,140,000 direct/yr1
CT DOSE Collaboration: Partnership for Dose	\$7,900,000 total

Collaboration across the US and Europe to standardize and optimize the doses used for CT. The study uses a novel randomized controlled trial design to compare simple feedback to a multicomponent intervention as strategies to optimize doses. There are approximately 125 hospitals participating in the trial.

PI	09/02/2013 - 08/31/2016
PCORI (Patient Centered Outcomes Research Institute)	\$492,163 direct/yr1
CT Radiation Dose Registry to Ensure a Patient Centered Approach for Imaging	\$2,069,365 total

Collaboration across the US and Europe to create benchmarks and standards for CT by pooling data from a large number of hospitals and outpatient facilities

PI	3/01/2015- 02/28/2020
NIH	\$1,834,410 direct/yr1
Risk of Cancer in Childhood Associated with Medical Imaging	\$10,600,000 total

Retrospective cohort across large integrated health care systems to assess imaging in pregnant women and children and to quantify the risk of childhood and adolescent cancer associated with these exposures.

PI (co-PI with Gould, Kaiser Foundation Research)	4/01/2015- 03/30/2020
PCORI	
Pragmatic Trial of More versus Less Intensive Strategies for Surveillance of Patients with Small Pulmonary Nodules	\$14,458,936 total

Prospective comparative effectiveness study across 15 health care systems to compare different strategies for the surveillance of lung nodules. The study is novel in that patients will be recruited with routine clinical care at imaging and the creation of systematic quality improvement strategies to ensure no loss to follow up.

Past

PI	10/01/2010 - 09/30/2013
AHRQ	\$4,830,368 direct/yr1
RCT of US versus CT for Patients with Suspected Renal Colic	\$9,210,000 total

15 Center randomized pragmatic comparative effectiveness trial comparing different strategies for imaging patients with suspected kidney stones. The study exceeded enrollment and follow up targets, and the primary results were published in the NEJM in 2014. Many additional analyses are ongoing using these data.

PI	09/01/2008 - 07/31/2015
NIH K24	\$172,000 direct/yr1
Mid-Career Development Award: Risk of Cancer Associated with Incidental Findings	\$868,632 total

PI	07/01/2011 - 07/01/2014
University of California Office of the President, CHQI	\$250,000 direct/yr1
Standardization and Optimization of CT Radiation Dose	\$750,000 total

Across the University of California Medical Centers.

Five-center observational study to collect radiation data across the five University of California campuses using automated techniques, analyze the sources of variation in dose, and conduct quality improvement initiatives to standardize practice

PI	09/30/2012 - 09/29/2014
CDC (Centers for Disease Control and Prevention)	\$250,000 direct/yr1
PEDS CT-DOSE: Pediatric CT Dose Optimization and Standardization Endeavor	\$500,000 total

Ten center observational study to collect radiation data and create benchmarks in children

Co-Investigator (PI Solberg, Health Partners)	07/01/2012 - 06/30/2014
PCORI (Patient Centered Outcomes Research Institute)	\$250,000 direct/yr1
Measuring Patient Outcome from High Tech Imaging Studies	\$500,000 total

Mixed methods study to understand imaging use, positive rates of imaging and patient perspectives on imaging, with respect to identifying patient centered outcomes important to patients.

PI	04/01/2009 - 03/31/2011
NIH / R21	\$317,000 total
Risk of Cancer with Incidental Findings Identified on US Imaging	

Retrospective cohort to understand cancer risks of incidental findings

PI	09/01/2008 - 08/31/2010
NIH / R21	\$317,000 total
Radiation Exposure from Imaging: are Doses in a Carcinogenic Range	

Retrospective cohort to understand use of medical imaging within integrated health care systems

PI	10/01/1999 - 07/01/2005
DOD	\$725,515 total
Outcomes of Screening Mammography in Elderly Women	

Medicare Data were analyzed to determine utilization of mammography and factors influencing survival

PI	09/01/1999 - 06/01/2005
NIH K07	\$635,687 total
Outcomes of Screening Mammography in Elderly Women	

NIH Career development award to study breast cancer screening among elderly women.

PI	07/01/2003 - 02/01/2007
California Breast Cancer Research Program	\$583,287 total
Racial Disparity in Breast Cancer Mortality	

Retrospective cohort to understand the causes for racial disparity in breast cancer outcomes

Co-Investigator (PI Kerlikowske UCSF) 04/01/2000 - 03/31/2005
NIH, U01 **\$3,100,000 total**
San Francisco Mammography Registry: A Research Resource

Dr. Smith-Bindman project lead on 1) Physician Predictors of Mammography Accuracy and 2) Validation of the Medicare Screening Algorithm

Co-Investigator (PI – McCune, UCSF) 09/30/2006 - 06/30/2011
NIH
Clinical and Translational Science Institute (CTSI)

The grant is to enhance training and infrastructure across UCSF. I participate in the Biomedical Informatics Program to educate trainees about imaging, epidemiology and study design

Co-Investigator (PI- Lu, UCSF) 04/01/2006 - 03/01/2009
NIH
Statistical Methods for Evaluation and Validation of Tests

Co-Investigator (PI Tlsty, UCSF)) 10/01/2005 - 09/30/2010
NIH
Biological Basis of Breast Density and Breast Cancer Risk

Co-Investigator (PI Esserman, UCSF) 05/01/2003 - 04/30/2007
Department of Defense/USAMRC **\$6,900,000 total**
Blueprint for Regional Excellence in Breast Cancer Care

PI 01/01/2002 - 12/01/2006
Women's Health Research Center, UCSF **\$70,000 total**
Down Syndrome Screening in the US

PI 04/01/2001 - 04/01/2003
Society of Radiologists in Ultrasound **\$40,000 total**
Prenatal Ultrasound for Detection of Birth Defects and Chromosome Abnormalities

PI 04/01/2001 - 04/01/2004
Society of Radiologists in Ultrasound **\$30,000 total**
Physician Variation in Ultrasound Accuracy

PI 07/01/2000 - 06/01/2001 **\$40,000 direct/yr**
Society of North America
U.S. U.K Comparison of The Accuracy of Screening Mammography

P
I 07/07/1999 - 06/01/2000 **\$35,000 direct**
Radiologic Society of North America
Prenatal diagnostic ultrasound for the detection of chromosomal Abnormalities

MOST SIGNIFICANT RESEARCH PUBLICATIONS

- 1) **Smith-Bindman et al. Endovaginal ultrasound to evaluate endometrial abnormalities JAMA 1999**
Vaginal bleeding affects 7% of post-menopausal women, and historically women have undergone an invasive endometrial biopsy to exclude a diagnosis of cancer. This meta-analytic review found that endovaginal ultrasound is an easily tolerated non-invasive test that is accurate for the diagnosis of cancer, so that most women can avoid the need for an endometrial biopsy if they have a normal ultrasound test result. These results have been integrated into clinical practice guidelines in the US, Scotland, England, Germany, and Hong Kong. The publication has been cited 427 times based on SCOPUS accessed in 2015.
- 2) **Smith-Bindman et al. Second-trimester ultrasound to detect fetuses with Down syndrome: a meta-analysis. JAMA. 2001.**
Prenatal ultrasound is widely used to screen for Down syndrome, but the impact on patients has not been well studied. This meta-analytic review suggests that the use of ultrasound for the detection of fetuses affected by Down syndrome may be associated with more harm than benefit, as it can lead to large numbers of unnecessary amniocenteses and subsequent fetal losses with little evidence of benefits. This article was accompanied by extensive media coverage (AP, Reuters, NY Times), and controversy, and prompted discussion regarding the role of ultrasound in prenatal diagnoses. The manuscript has been cited 217 times based on SCOPUS accessed in 2015.
- 3) **Smith-Bindman R et al. US-UK Comparison of Screening Mammography. JAMA 2003.**
Screening mammography is an imprecise test, and there are considerable differences between physicians and programs in the accuracy of screening. This international comparison of screening mammography described 5.5 million mammograms obtained between 1996 to 1999 within three large-scale mammography registries or screening programs. Recall rates and open surgical biopsy rates were twice as high in the U.S. as in the U.K., although cancer rates were nearly identical. There was extensive media coverage (AP, Reuters, NY Times, Wall Street Journal, National Public Radio). These results have been widely cited, and were included in the IOM Report, "Saving Women's Lives." The publication was cited 223 times based on SCOPUS accessed in 2015.
- 4) **Smith-Bindman et al. Physician Predictors of Mammographic Accuracy. J Natl Cancer Inst 2005.**
Beyond the issues raised about the collective quality of mammographic screening in the United States, even more pronounced concern is the glaring variation among U.S. physicians in the ability to accurately interpretation their patients' mammograms. Dr. Smith-Bindman studied the accuracy of mammographic screening among 208 U.S. physicians, who collectively interpreted 1.2 million mammograms, and she found extraordinary variation in the interpretive abilities of radiologists; the sensitivity spanned 29% to 97%, while the false positive rate (the percentage of women who did not have cancer, but who underwent additional diagnostic testing or biopsy at their physician's recommendation) ranged from 1 to 29%. The difference in accuracy was principally due to differences in their training, experience and dedication to screening mammography; in short, the more experienced mammographers - and those who read more than the minimum number of mammograms required by MQSA guidelines - did substantially better. These findings have already been integrated into the Institute of Medicine's report on Mammography Quality Standards, regarding Enhancement of Interpretative Performance. The manuscript was cited 82 times based on SCOPUS accessed in 2015.
- 5) **Smith-Bindman et al. Does Utilization of Screening Mammography Explain Racial and Ethnic Differences in Breast Cancer? Ann Intern Med, 2006**
Racial and ethnic minorities tend to have larger, more advanced stage breast cancers at diagnosis than white women, and African American women have significantly higher breast cancer mortality. It has not been clear, however, if this is due to inherent differences in biology or the utilization of screening mammography. This paper sought to disentangle whether biology or the use of screening was largely responsible for the known racial and ethnic differences in breast cancer. This study was

unique in that detailed cancer information was available from tumor registries that were linked with detailed information regarding mammography utilization. The results were striking. Most of the racial and ethnic differences in breast cancer features were reduced or eliminated after accounting for the frequency of mammography screening. The manuscript was cited 175 times on SCOPUS.

6) **Smith-Bindman et al. Second trimester prenatal ultrasound for the detection of pregnancies at increased risk of Down syndrome. Prenat Diagn 2007** *Prenatal ultrasound is widely used to screen for Down syndrome, but the impact on patients has not been well studied. Our meta-analytic review found that ultrasound was not useful and this prompted our large prospective study which evaluated ultrasound in a larger cohort, including nearly 20,000 women, in whom nearly 500 had fetuses affected by Down syndrome. This large study confirmed these preliminary results. The manuscript was cited 51 times on SCOPUS.*

7) **Smith-Bindman et al. Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. JAMA Internal Medicine 2009** *This paper documented the variation in doses associated with routine CT. The widespread media attention that this paper received contributed to active policy discussion in this area. I was invited to present and discuss the results at the FDA, at a Congressional Hearing sponsored by the Health Subcommittee of the Committee on Energy and Commerce, and innumerable professional society meetings, and submitted (and had endorsed) a measure of quality around CT imaging by the National Quality Forum. The manuscript was cited 857 times based on SCOPUS accessed in 2015.*

8) **Smith-Bindman R, Appendix F. Ionizing Radiation Exposure to the US Population, with a Focus on Radiation from Medical Imaging, in Breast and the Environment: A Life Course Approach. The Institute of Medicine. 2012** *The IOM was commissioned to write a report on environmental causes of breast cancer. The Komen Foundation commissioned the report. I was asked to summarize what is known about the harmful effects of ionizing radiation on breast cancer risks. The IOM concluded that ionizing radiation is one of the largest, and the most preventable causes of breast cancer.*

9) **Miglioretti DL et al. Smith-Bindman senior author. The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. JAMA Pediatr. 2013** *Using a retrospective cohort design, this paper quantified the use of imaging among children within one of 7 large integrated health care systems, quantified the radiation exposure associated with these examinations, and estimated the likely impact of improved standardization of the conduct of CT on the risks of cancer. The manuscript concluded that if the top outlying radiation exposures could be reduced to the average (a modest goal) that 40% of expected cancer could be eliminated. The manuscript was cited 150 times based on SCOPUS accessed in 2015*

10) **Smith-Bindman R, et al. Risk of Thyroid Cancer based on Thyroid Ultrasound Imaging Characteristic: Result of A Population Based-Study. JAMA Internal Medicine. 2013.** *This retrospective observational study documented the risk of cancer associated with specific thyroid imaging findings. This is the first study that links a large cohort of patients with detailed imaging findings, with a comprehensive tumor registry to permit the quantification of the risk of cancer associated with specific findings. The results suggest that the number of biopsies can be reduced by up to 90%, with a relatively small impact on cancer detected. The results are being rapidly embraced by endocrinologists, surgeons and radiologists.*

11) **Smith-Bindman et al Ultrasound versus Computed Tomography for Suspected Nephrolithiasis NEJM. 2014.** *This 15-center randomized comparative effectiveness study assessed whether ultrasound or CT should be the first imaging test in patients with suspected kidney stones. The study is unique in using a rigorous randomized trial design to assess a diagnostic imaging test, and in assessing a broad range of outcomes other than diagnostic accuracy. Emergency department patients with abdominal pain and suspected nephrolithiasis*

were randomly assigned to one of three arms for imaging: ultrasound performed by an emergency medicine physician, ultrasound provided by a radiologist, or computerized tomography (CT). No significant differences were observed over the next 6 months in rates of severe serious adverse events (SAEs), related SAEs, or total SAEs, or ED or hospital admission rates at 7 or 30 days; however, initial imaging with ultrasound was associated with lower 1 day and 6-month cumulative radiation exposures than initial imaging with CT. The manuscript was cited 45 times based on SCOPUS accessed in 2015

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Current Exposure to Computed Tomography Imaging in US Integrated Health Care Systems, presented at the Conference on Radiation in Health by the Radiation Research Society, Kona, HI, 10/15-17, 2016

Current CT doses from a Computed Tomography Dose Registry in Pediatric Patients, Presented at the American Academy of Pediatrics Annual Meeting, San Francisco, CA, 10/22-25/2017

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Practical Strategies for Optimizing Dose, A Dose of Reality

European Congress of Radiology, European Society of Radiology, 2018
An International Randomized Controlled Trial of Two Interventions for Reducing Doses for Computed Tomography (CT) Through Audit Feedback and Sharing Best Practices

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Exhibit B

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Exhibit C

Rebecca Smith-Bindman Compensation and Prior Testimony

Dr. Smith-Bindman's fees are \$1,000/hr. She has not testified in other cases during the previous four years.

Exhibit 46

1 IN THE UNITED STATES DISTRICT COURT
2 FOR THE EASTERN DISTRICT OF NEW JERSEY

3

4

IN RE: JOHNSON & JOHNSON
TALCUM POWDER PRODUCTS
MARKETING, SALES PRACTICES,
AND PRODUCTS LIABILITY
LITIGATION

7

Case No. 16-2738

8

THIS DOCUMENT RELATES TO (FLW) (LHG)

9

ALL CASES

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MDL Docket No. 2738

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Wednesday, January 30, 2019

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The video deposition of ROBERT COOK, Ph.D.,

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taken pursuant to notice, was held at the

16

Hilton Garden Inn, 2555 Hilton Garden Drive,

17

Auburn, Alabama, commencing at approximately

18

8:56 a.m., on the above date, before Lois Anne

19

Robinson, Registered Diplomate Reporter,

20

Certified Realtime Reporter, and

21

Notary Public for the State of Alabama.

22

23

24

Robert H. Cook, Ph.D.
59501

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<p>1 A P P E A R A N C E S - (continued)</p> <p>2</p> <p>3 COUNSEL FOR PERSONAL CARE PRODUCTS COUNCIL:</p> <p>4 SEYFARTH SHAW LLP</p> <p>5 975 F Street N.W.</p> <p>6 Washington, D.C. 20004-1454</p> <p>7 BY: JAMES R. BILLINGS-KANG, ESQUIRE</p> <p>8 Jbillingskang@seyfarth.com</p> <p>9 COUNSEL FOR PHARMATECH INDUSTRIES (PTI):</p> <p>10</p> <p>11 TUCKER ELLIS, LLP</p> <p>12 950 Main Avenue, Suite 1100</p> <p>13 Cleveland, Ohio 44113</p> <p>14 BY: TARIQ M. NAEEM, ESQUIRE</p> <p>15 Tariq.Naeem@TuckerEllis.com</p> <p>16 VIDEOGRAPHER:</p> <p>17 Julie Robinson</p> <p>18</p> <p>19 LOIS ANNE ROBINSON, RPR, RDR, CRR</p> <p>20 COURT REPORTER</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p>	<p>1 I N D E X - (continued)</p> <p>2 11 Article - "Using the geologic setting of talc 164</p> <p>3 deposits as an indicator of amphibole asbestos content</p> <p>4 12 IARC Monographs on the Evaluation of Carcinogenic 165</p> <p>5 Risks to Humans, Volume 93</p> <p>6 13 "6. Cosmetics" 170</p> <p>7 14 IMERY'S-A_0015758 to 61 - Characterization of 198</p> <p>8 the Guangxi #1 Crude and Cimpact 710 Product</p> <p>9 15 "Perineal Powder Exposure and the Risk of 235</p> <p>10 Ovarian Cancer" JNJ000030983 - 994</p> <p>11 16 "Perineal Powder Exposure and the Risk of 237</p> <p>12 Ovarian Cancer" JNJ000016791 797</p> <p>13 17 Colorado School of Mines Research Institute 238</p> <p>14 Letter of 2/3/77 to W. H. Ashton from Jerry Krause</p> <p>15 18 J&J Worldwide Talc Sources, February 1975 239</p> <p>16 19 Department of Mineral Exploitation - 240</p> <p>17 JNJ000322351 -475</p> <p>18 20 Methodology X-Ray limitations; 8/6/71 letter 246</p> <p>19 to W. T. Canear from W. Ashton</p> <p>20 21 Asbestos Content of Talcs from Italian mines and 253</p> <p>21 fibre concentration in various commercial talcum powders</p> <p>22 used in Italy. (Marconi and Verdel)</p> <p>23 22 Talc Resources of the United States 260</p> <p>24 23 "Dusts and Disease" 263</p>

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<p>1 I N D E X - (continued)</p> <p>2 34-2 BATES Documents IIMERYYS210707 - 885; 507</p> <p>3 IMERYYS427326 427415</p> <p>4 34-3 Bates Documents IMERYYS430707 - JNJ000270588 507</p> <p>5 34-4 Bates Documents JNJ00059273 - JNJI4T5_000005163504</p> <p>6 34-5 Bates Documents JNJMX68_000004296 - LUZ015663 507</p> <p>7 34-6 Core Logs and Maps 507</p> <p>8 34-7 Depositions of Pat Downey - John Hopkins Part 1 507</p> <p>9 34-8 Deposition of John Hopkins Part 2 507</p> <p>10 34-9 Deposition of John Hopkins Part 3 and 507</p> <p>11 Julie Pier Part 1</p> <p>12 34-10 Deposition of Julie Pier Part 2 and Blount 507</p> <p>13 (Ingham)</p> <p>14 34-11 Literature - Blount (1991) - IARC (1987) 507</p> <p>15 Supp. 7</p> <p>16 34-12 Literature - IARC (2006) Preamble and IARC 507</p> <p>17 (2010)</p> <p>18 34-13 Literature - IARC (2012) and Zeitz Memo (1974) 507</p> <p>19 35 William E. Longo, Ph.D./Mark W Rigler Ph.D. - 507</p> <p>20 State Court Reports</p> <p>21 36 Longo Supplement Volume 1 507</p> <p>22 37 Longo Supplement Volume 2 507</p> <p>23</p> <p>24</p>	<p>1 VIDEOGRAPHER:</p> <p>2 We are now on the record.</p> <p>3 My name is Julie Robinson. I'm a</p> <p>4 videographer representing Golkow Litigation</p> <p>5 Services.</p> <p>6 Today's date is January 30th, 2019, and</p> <p>7 the time is 8:56 a.m.</p> <p>8 This video deposition is being held in</p> <p>9 Auburn, Alabama, in the matter of</p> <p>10 Johnson & Johnson Talcum Powder Product</p> <p>11 Marketing, Sales Practices, and Products</p> <p>12 Liability Litigation, MDL Docket Number 2738.</p> <p>13 The deponent is Dr. Robert B. Cook.</p> <p>14 Will counsel please state appearances</p> <p>15 for the record.</p> <p>16 MS. O'DELL:</p> <p>17 Leigh O'Dell, Beasley Allen, for the</p> <p>18 plaintiffs.</p> <p>19 MS. EMMELL:</p> <p>20 Jennifer Emmell, Beasley Allen, for the</p> <p>21 plaintiffs.</p> <p>22 MR. LAPINSKI:</p> <p>23 Daniel Lapinski, the Wilentz Law Firm,</p> <p>24 for the plaintiffs.</p>

<p style="text-align: right;">Page 10</p> <p>1 MR. FROST:</p> <p>2 Jack Frost, Drinker Biddle & Reath, on</p> <p>3 behalf of Johnson & Johnson.</p> <p>4 MS. McBETH:</p> <p>5 Catherine McBeth, Drinker Biddle &</p> <p>6 Reath, on behalf of Johnson & Johnson.</p> <p>7 MR. FERGUSON:</p> <p>8 Ken Ferguson, Gordon & Rees, for</p> <p>9 Imerys.</p> <p>10 MR. CARY:</p> <p>11 Andrew Cary, Gordon & Rees, for Imerys.</p> <p>12 VIDEOGRAPHER:</p> <p>13 The court reporter is Lois Robinson,</p> <p>14 who will now swear in the witness.</p> <p>15 THE COURT REPORTER:</p> <p>16 We just had someone arrive.</p> <p>17 Do you want to state your appearances?</p> <p>18 MR. BILLINGS-KANG:</p> <p>19 Sure.</p> <p>20 This is James Billings-Kang on behalf</p> <p>21 of Personal Care Products Council.</p> <p>22 ROBERT B. COOK, Ph.D.,</p> <p>23 the witness, after having first been</p> <p>24 duly sworn to tell the truth, the whole truth,</p>	<p style="text-align: right;">Page 12</p> <p>1 as Exhibits 1 and 2. And do you recognize these</p> <p>2 are the reports that you drafted in this matter?</p> <p>3 A The cover pages are correct, and I</p> <p>4 assume that the contents are.</p> <p>5 Q Okay. And other than these two</p> <p>6 reports, do you have any other reports, written</p> <p>7 research, anything else that you've created for</p> <p>8 this matter that isn't reflected by those?</p> <p>9 A I have a few handwritten notes that I</p> <p>10 brought in response to your request.</p> <p>11 Q Okay. Could I see those?</p> <p>12 A (Witness complies.)</p> <p>13 Q We'll mark them now, and I'll take a</p> <p>14 look at them during the break.</p> <p>15 A Yeah.</p> <p>16 MR. FROST:</p> <p>17 Could you mark this as Exhibit 3,</p> <p>18 please.</p> <p>19 (DEPOSITION EXHIBIT NUMBER 3</p> <p>20 WAS MARKED FOR IDENTIFICATION.)</p> <p>21 MR. FROST:</p> <p>22 Q And then I also note counsel brought a</p> <p>23 collection of invoices today. I'll mark those as</p> <p>24 Exhibit 4.</p>
<p style="text-align: right;">Page 11</p> <p>1 and nothing but the truth, was examined and</p> <p>2 testified as follows:</p> <p>3 EXAMINATION</p> <p>4 BY MR. FROST:</p> <p>5 Q All right. Good morning, Dr. Cook.</p> <p>6 A Good morning.</p> <p>7 Q My name is Jack Frost, and I'll be</p> <p>8 asking the majority of the questions today.</p> <p>9 A Okay.</p> <p>10 Q Before we get started, have you ever</p> <p>11 been deposed before?</p> <p>12 A Yes.</p> <p>13 Q Okay. So you generally know how this</p> <p>14 works. We've got to verbalize all our answers.</p> <p>15 A Correct.</p> <p>16 Q Hand gestures, uh-huhs, huh-uhs don't</p> <p>17 work. And, other than that, we need to be</p> <p>18 careful not to speak over each other.</p> <p>19 All right. Can I please mark these</p> <p>20 two?</p> <p>21 (DEPOSITION EXHIBITS 1 AND 2</p> <p>22 WERE MARKED FOR IDENTIFICATION.)</p> <p>23 MR. FROST:</p> <p>24 Q I'm gonna hand you what's been marked</p>	<p style="text-align: right;">Page 13</p> <p>1 (DEPOSITION EXHIBIT NUMBER 4</p> <p>2 WAS MARKED FOR IDENTIFICATION.)</p> <p>3 MR. FROST:</p> <p>4 Q All right. So other than the two</p> <p>5 reports and your notes, is there anything else,</p> <p>6 any other writings that you have that reflects</p> <p>7 any of the work you've done in this case?</p> <p>8 A Well, I brought a -- some photographs</p> <p>9 of my personal library, which -- which I used to</p> <p>10 gather my -- my background information.</p> <p>11 Q Okay.</p> <p>12 A And I brought photographs because I</p> <p>13 donated my library to a museum that maintains a</p> <p>14 research library in Atlanta just a couple months</p> <p>15 ago.</p> <p>16 Q That's okay.</p> <p>17 A If you'd like to see what I was using,</p> <p>18 I brought pictures of it.</p> <p>19 Q Yeah.</p> <p>20 MR. FROST:</p> <p>21 I think what we'll do, Leigh, is at the</p> <p>22 end, we'll do like we did with -- for</p> <p>23 Dr. Crocker. We'll somehow figure out a way to</p> <p>24 mark everything that's been brought and, you</p>

<p style="text-align: right;">Page 14</p> <p>1 know, we'll figure out during a break what the 2 best way to -- to do that is. So we'll -- for 3 now we can refer to the stuff that's on the 4 table. 5 Q It looks like you brought a collection 6 of documents, literature, and, as you said, the 7 picture of your library. 8 A Yes. And a publication on amphiboles, 9 if there were any questions about amphiboles. 10 Q Okay. 11 A Just a good summary document. 12 Q All right. And is that, the book on 13 amphiboles, is that in the materials relied upon? 14 A Well, I relied on it. I don't remember 15 whether we listed it or not. It's -- 16 MS. O'DELL: 17 I believe it to be. 18 MR. FROST: 19 It is reflected? 20 MS. O'DELL: 21 I believe it to be reflected. But we 22 can go through -- 23 MR. FROST: 24 I was going to say, we can always</p>	<p style="text-align: right;">Page 16</p> <p>1 sitting here today, you don't intend to offer any 2 additional opinions that aren't otherwise set 3 forth in these reports? 4 A That's correct. 5 Q And do you believe the reports to be 6 accurate and complete? 7 A When you say "the reports," you mean 8 these two reports? 9 Q Yes. 10 A Yes. 11 Q Yes. These, Exhibit 1 and Exhibit 2. 12 A Yes. 13 Q And is it fair to summarize the 14 opinions you're rendering in this case all relate 15 to geology, mineralogy, and sort of mining 16 practices? 17 A It's -- it goes beyond that in that I 18 am offering opinions related to sampling and 19 analytical techniques. 20 Q Okay. I'd loop that under the mining. 21 A Yeah. 22 Q Other than the geology, mineralogy, 23 mining practices, and the sampling and 24 compositing techniques, is there anything else</p>
<p style="text-align: right;">Page 15</p> <p>1 check -- 2 MS. O'DELL: 3 Yeah. 4 MR. FROST: 5 -- that during a break as well. 6 Q All right. Excellent. 7 So you understand that you've been 8 retained by plaintiffs to be an expert in this 9 talc MDL; is that correct? 10 A Correct. 11 Q And you understand that you're offering 12 some opinions in this case; right? 13 A Correct. 14 Q All the opinions that you plan to offer 15 in this case, are they all reflected in the two 16 reports that we've marked as Exhibits 1 and 2? 17 A Yes. Based on the reports as they 18 stand, yes. I did reserve the right to -- to 19 supplement these reports if additional 20 information is supplied. 21 Q Okay. 22 A But, yes, my opinions are pretty much 23 everything that I -- I wanted to say. 24 Q All right. So is it fair to say that,</p>	<p style="text-align: right;">Page 17</p> <p>1 you intend to offer opinions on here today? 2 A No. 3 Q And, in fact, you don't intend to offer 4 any opinions on whether or not talc or talcum 5 powder can cause ovarian cancer; correct? 6 A No. No. 7 Q And same with mesothelioma. You don't 8 intend to offer opinions that talc or talcum 9 powder can cause mesothelioma? 10 A No. 11 MS. O'DELL: 12 Dr. Cook, if you'd just wait till Jack 13 finishes. 14 THE WITNESS: 15 Uh-huh. 16 MS. O'DELL: 17 Can you just -- 18 THE WITNESS: 19 Okay. 20 MS. O'DELL: 21 Another couple of seconds. That will 22 be helpful. 23 MR. FROST: 24 Q Turning to Exhibit 2, this is captioned</p>

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1 as an amended report -- is that correct? --

2 that -- the Exhibit 2, the second of the two

3 reports?

4 A Yes.

5 Q Okay. And why did you issue an amended

6 report in this case?

7 A Additional information came in, and in

8 editing my own original first version, I found

9 grammatical errors and that type of thing, which,

10 being a retired professor, I can't abide.

11 Q Do you recall what additional

12 information came in that you reviewed?

13 A There were depositions by several

14 people. There was a McCarthy report related to

15 beneficiation. There was information related --

16 additional information related to Italian talc.

17 There was a stack of documents that I received

18 primarily online in -- in a Dropbox.

19 Q The depositions by several people you

20 received, do you recall what depositions those

21 were?

22 A Two of them were by people that were

23 not really involved in this, but they -- they

24 offered information related to the -- the

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1 mineralogy of talc and related amphiboles. One

2 was by Mickey Gunter. One was by a man named

3 Sanchez, who was one of Gunter's students. There

4 was a deposition by a man named Glassley, who

5 once worked in Vermont. Those were the three

6 that I remember.

7 Q Do you recall the dates on those

8 depositions?

9 A No.

10 Q Do you recall if those depositions were

11 taken after you had drafted your initial report?

12 A I think that they were all before.

13 Q They were all before?

14 A Uh-huh.

15 Q And those had not been made available

16 to you prior to your first report?

17 A No.

18 Q And I take it plaintiffs' counsel

19 provided those depositions to you?

20 A Yes.

21 Q Did plaintiffs' counsel advise you as

22 to why they were providing those depositions to

23 you?

24 A No.

Page 20

1 MS. O'DELL:

2 Excuse me. And just to any questions

3 that would -- would require you to disclose

4 things that we've discussed, those would be

5 things that are protected by the work product

6 privilege, and --

7 THE WITNESS:

8 Right.

9 MS. O'DELL:

10 -- and I would ask you not to --

11 THE WITNESS:

12 Right.

13 MS. O'DELL:

14 -- testify to those. And I -- I'll be

15 careful to object to --

16 THE WITNESS:

17 Correct.

18 MS. O'DELL:

19 -- a specific question.

20 MR. FROST:

21 Q And your counsel is correct. I'm

22 allowed to know data, documents, things like

23 that, and other things that they gave you or told

24 you that influenced your opinion in this case,

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1 but not communications, necessarily, between the

2 two.

3 A I understand.

4 The -- the flow of documents has been

5 sort of a continual thing. It -- it's not that,

6 "Okay" --

7 I -- I finished writing my -- my report

8 in '08.

9 -- "we've got another big pile of

10 documents we want you to see."

11 They would enter material into my

12 Dropbox routinely, I mean, maybe a couple times a

13 week. Because, apparently, material was being

14 supplied all along by Johnson & Johnson or Imerys

15 or someone. And as they would scan or screen the

16 material, if it was -- if they were things that

17 would relate to what I was looking at, then they

18 would enter them into my Dropbox and alert me.

19 But there was no -- no instructions in

20 -- in terms of what I should be looking at or for

21 or anything like that. It was just, "Here's more

22 information."

23 Q All right. When did plaintiffs --

24 And I take it, by "they," you're

<p style="text-align: right;">Page 22</p> <p>1 referring to plaintiffs' counsel?</p> <p>2 A Correct.</p> <p>3 Q When did plaintiffs' counsel start</p> <p>4 sending you documents for your review in this</p> <p>5 case?</p> <p>6 A Ms. O'Dell contacted me, I think, in</p> <p>7 April of 2017, and she supplied me -- you know,</p> <p>8 after discussing the -- the -- what she would</p> <p>9 like for me to do, I agreed, and she began to</p> <p>10 give me background information, including, you</p> <p>11 know, the documents that you see here, I think</p> <p>12 still in late April of 2017.</p> <p>13 Q And plaintiffs' counsel continued to</p> <p>14 supply you documents through --</p> <p>15 A Still going on.</p> <p>16 Q Still -- they're still --</p> <p>17 A Sure.</p> <p>18 Q -- continuing to supply you documents</p> <p>19 now?</p> <p>20 A Sure.</p> <p>21 Q And it sounds like you have a -- a</p> <p>22 Dropbox that they're loading documents into?</p> <p>23 A Yes.</p> <p>24 Q Is that the only way that they're</p>	<p style="text-align: right;">Page 24</p> <p>1 Q Did they mark the pages of interest for</p> <p>2 you to look at before you wrote your report?</p> <p>3 A No. No.</p> <p>4 Q Okay. This was all done in preparation</p> <p>5 for the deposition --</p> <p>6 A Oh, yes.</p> <p>7 Q -- today?</p> <p>8 A Just within the last day or so.</p> <p>9 Q Okay. I'll rephrase my question.</p> <p>10 So, in sending you documents, at any</p> <p>11 time that you were being sent documents that you</p> <p>12 were gonna rely on for your report, did they ever</p> <p>13 send documents that were already tabbed or</p> <p>14 highlighted or had any annotations on them?</p> <p>15 A Highlighted, some of these look like</p> <p>16 they had been highlighted years ago, because they</p> <p>17 were xeroxed copies and you could see where there</p> <p>18 was a -- a different shade of gray.</p> <p>19 Q Uh-huh.</p> <p>20 A And, so, yes, there were documents like</p> <p>21 that. And occasionally I would get something</p> <p>22 that would have a yellow -- yellow highlighter on</p> <p>23 it, and it may or may not have related to what I</p> <p>24 was, you know, supposed to be looking at.</p>
<p style="text-align: right;">Page 23</p> <p>1 sending you documents?</p> <p>2 A No. No. Sometimes they'll print them</p> <p>3 out for me. These were printed out in -- in</p> <p>4 Montgomery. I didn't print them out on my HP</p> <p>5 bottom-of-the-line printer.</p> <p>6 Q And looking over at the binders that</p> <p>7 are on the table, I note that there are tabs and</p> <p>8 sort of stickies and things like that --</p> <p>9 A Sure.</p> <p>10 Q -- throughout them. Are those things</p> <p>11 that you put in, or did they come that way from</p> <p>12 plaintiffs' counsel?</p> <p>13 A No. It's -- it's -- it's a little</p> <p>14 of -- of both. These are the actual documents</p> <p>15 that I referred to in my report. And some of</p> <p>16 them are long --</p> <p>17 Q Uh-huh.</p> <p>18 A -- and there may be only one page that</p> <p>19 I'm actually referencing. And, so, I've gone</p> <p>20 through, with their help, and marked that page so</p> <p>21 that if you ask me about a document, I -- we</p> <p>22 don't spend two hours as I kind of try to figure</p> <p>23 out which page out of a hundred pages we need to</p> <p>24 find a quote on.</p>	<p style="text-align: right;">Page 25</p> <p>1 Q Okay. Did you use these highlights and</p> <p>2 things of that nature to help influence what you</p> <p>3 were looking at or writing in your report?</p> <p>4 A No. But -- but I couldn't help but</p> <p>5 wonder why they were highlighted, so I, of</p> <p>6 course, looked at them. And some of them were</p> <p>7 of -- of value, and some weren't.</p> <p>8 I mean, you'll -- I mean, even though</p> <p>9 this looks like a lot of material, this isn't --</p> <p>10 it's not half of what they sent. And I -- I have</p> <p>11 looked at every page. I won't -- won't say I've</p> <p>12 read every page, but I've certainly looked at</p> <p>13 every page that they sent.</p> <p>14 I mean, you know, you can't go through</p> <p>15 the IARC stuff without falling asleep repeatedly.</p> <p>16 So, you know, you just can't read all that. But</p> <p>17 you can look at it, looking for, you know, key</p> <p>18 words and things like that.</p> <p>19 Q Okay. Regarding the Imerys and</p> <p>20 Johnson & Johnson documents that you've been</p> <p>21 provided in this case, I take it everything you</p> <p>22 have has been provided to you by plaintiffs'</p> <p>23 counsel?</p> <p>24 A Other -- other than the material in my</p>

<p style="text-align: right;">Page 26</p> <p>1 own library, which --</p> <p>2 Q Uh-huh.</p> <p>3 A -- which, you know, some of it's</p> <p>4 been -- been referenced in my report. And</p> <p>5 there's a lot of other stuff that, you know,</p> <p>6 there would be no need to reference but yet it</p> <p>7 deals with talc.</p> <p>8 Q Did plaintiffs' counsel provide you any</p> <p>9 of the published literature you relied on in your</p> <p>10 reports?</p> <p>11 A They've supplied me with the IARC</p> <p>12 stuff, if you want to consider that published,</p> <p>13 which I do. But in terms of copies of certain</p> <p>14 published papers that were in journals, yes, they</p> <p>15 supplied me with some full copies of things that</p> <p>16 I only had abstracts of.</p> <p>17 And -- and, in fact, there was one that</p> <p>18 I couldn't -- I had a -- I had a really good</p> <p>19 reference to it, but I couldn't come up with it,</p> <p>20 and it's from a field trip guide book in Italy.</p> <p>21 And they supplied me with that.</p> <p>22 Q Did plaintiffs -- I guess, better way</p> <p>23 of asking this, did plaintiffs supply you with</p> <p>24 any published literature other than the two IARC</p>	<p style="text-align: right;">Page 28</p> <p>1 already had copies of. Some they gave me a copy</p> <p>2 of and I already had it.</p> <p>3 Q Uh-huh.</p> <p>4 A So there's sort of a -- of an overlap</p> <p>5 there.</p> <p>6 Q Okay. Was there anything that they</p> <p>7 supplied you that you'd never seen before that</p> <p>8 influenced or changed your opinions in this case?</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 Do you mean like in --</p> <p>12 MR. FROST:</p> <p>13 I'm talking about literature.</p> <p>14 MS. O'DELL:</p> <p>15 Okay. Was it --</p> <p>16 I'm sorry.</p> <p>17 MR. FROST:</p> <p>18 Yeah, I was going to say --</p> <p>19 MS. O'DELL:</p> <p>20 That was my objection.</p> <p>21 MR. FROST:</p> <p>22 You're correct. My question wasn't</p> <p>23 clear.</p> <p>24 Q Focusing on literature, was there any</p>
<p style="text-align: right;">Page 27</p> <p>1 publications on their own, or was it all stuff</p> <p>2 that you had requested if they could get copies</p> <p>3 of for you?</p> <p>4 A No. I -- I'm sure that if we went back</p> <p>5 through everything I had, there would be copies</p> <p>6 of publications. There were some Bureau of Mines</p> <p>7 publications. There was a USGS publication.</p> <p>8 Um --</p> <p>9 Q And I don't mean to cut you off, but</p> <p>10 were these publications that you asked to see or</p> <p>11 were these publications that plaintiffs' counsel</p> <p>12 sent you and told you --</p> <p>13 A It was a --</p> <p>14 Q -- to look at?</p> <p>15 A It was a little bit of both.</p> <p>16 Q Little bit --</p> <p>17 A If you --</p> <p>18 Q -- of both?</p> <p>19 A If you look -- if you look at the back</p> <p>20 of my report, there's an enormous long listing</p> <p>21 of -- of materials that I -- I relied on. And</p> <p>22 this is -- this is pretty much the list of things</p> <p>23 that -- that -- that I -- I have looked at. Some</p> <p>24 of those were supplied by Beasley Allen. Some I</p>	<p style="text-align: right;">Page 29</p> <p>1 literature that plaintiffs' counsel forwarded you</p> <p>2 that influenced -- influenced or changed the</p> <p>3 opinions that you were gonna render in this case?</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 A No. And there -- there's -- there's a</p> <p>7 reason for that. I didn't have a lot of</p> <p>8 opinions. I hadn't thought about the -- the</p> <p>9 talc-ovarian cancer issue at all until Ms. O'Dell</p> <p>10 called me. So I had -- I had very few opinions.</p> <p>11 I was familiar with the geology, and I</p> <p>12 know a lot about mining, and, so, you know, my --</p> <p>13 my fundamental knowledge and ideas in those two</p> <p>14 areas were already pretty well established.</p> <p>15 And, so, from the standpoint of -- of</p> <p>16 those, the mineralogy, there was nothing that --</p> <p>17 I mean, there's some errors in the mineralogy</p> <p>18 that, you know, that's floating around right now.</p> <p>19 But that was information I knew already.</p> <p>20 The -- a couple of the papers that I --</p> <p>21 I found in dealing with the Italian talc deposits</p> <p>22 enhanced what I knew. They were -- they were</p> <p>23 interesting.</p> <p>24 MR. FROST:</p>

<p style="text-align: right;">Page 30</p> <p>1 Q Okay. If -- if we were to go through 2 the -- the reference list at the back of your 3 report, would you be able to tell me what was 4 supplied to you by plaintiffs that you didn't 5 already have? 6 A Hmm. 7 MS. O'DELL: 8 Are you limiting that to the 9 literature? 10 MR. FROST: 11 I gotcha. 12 Yeah, to the literature. 13 THE WITNESS: 14 Did we put all the IARC stuff in -- in 15 literature? 16 I mean, some of it has Bates numbers. 17 And if it was a Bates number, then they obviously 18 supplied it to me. Doesn't mean I didn't already 19 have a copy of it. 20 If it was a -- if it was a company 21 document of some sort, obviously, I never had a 22 copy of it. 23 But there -- I could sit down and maybe 24 go through the list with you and show you which</p>	<p style="text-align: right;">Page 32</p> <p>1 geology of the -- the relevant talc deposits. 2 Q Do you recall what you asked for? 3 A Well, just happen to have written it 4 down. 5 Yeah. There you go. 6 That's a fairly comprehensive list of 7 what I asked for. 8 MR. FROST: 9 Mark this as Exhibit 5. I think we're 10 on 5; right? 11 THE COURT REPORTER: 12 Yes, uh-huh. 13 MR. FROST: 14 Thank you. 15 (DEPOSITION EXHIBIT NUMBER 5 16 WAS MARKED FOR IDENTIFICATION.) 17 MR. FROST: 18 Q Okay. I'll hand this back to you. 19 A Okay. 20 Q So you believe that's a fairly 21 comprehensive list of all the documents you asked 22 for from plaintiffs' counsel? 23 A It probably isn't, because this has 24 been going on -- we're pushing two years now.</p>
<p style="text-align: right;">Page 31</p> <p>1 things that -- that they may have given me, but 2 it's not gonna be -- isn't anything consequential 3 relative to the materials I already had. 4 MR. FROST: 5 Okay. I'm gonna ask maybe we'll do 6 that during a break or something -- 7 THE WITNESS: 8 Yeah. 9 MR. FROST: 10 -- if we can highlight on the Exhibit 11 2, you know, what he believes was supplied by 12 plaintiffs' counsel. That might be helpful. 13 A It's -- it's mainly documents related 14 to governmental agencies, that type of thing, 15 that I would not have had in my -- my library up 16 until this point. 17 MR. FROST: 18 Q Okay. Turning to the company 19 documents, did you make a particular request for 20 documents or the type of documents that you would 21 want to see, or did plaintiffs' counsel just 22 provide you documents? 23 A No. I did. I made a request for a 24 long list of things related to the mining and</p>	<p style="text-align: right;">Page 33</p> <p>1 And I'm sure there were instances when -- when we 2 were talking on the phone and I'd say, "Do we -- 3 do we have anything related to froth flotation 4 that was used at West Windsor?" I mean, I might 5 have -- I might have, you know, couched a 6 question like that. 7 So I would say that, in all fairness, I 8 probably did ask for other things. 9 Q Sitting here today, you couldn't come 10 up with a -- a list -- 11 A No. 12 Q -- of what those other things may be? 13 A No. 14 Q Do they all generally relate to the 15 categories that are, you know, in there, which 16 appear to be kind of the geology, mineralogy of 17 the three districts -- 18 A Yes. 19 Q -- and then the mining practices of the 20 two companies? 21 A Yes. 22 Q And did you ever ask for any documents 23 that you weren't provided? 24 A I don't think so.</p>

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1 Q Did you ever ask to conduct your own
2 searches of all of the documents provided by the
3 two corporate defendants in this case?
4 A I'm -- I'm not sure I understand what
5 you're asking.
6 Q Sure. Did you ever ask for access to
7 all of the documents that have been produced in
8 this case by --
9 A No.
10 Q -- either Johnson & Johnson or Imerys?
11 A No.
12 Q Did you ever ask to be able to run any
13 searches yourself against a database, say, of all
14 of those documents?
15 A No.
16 Q So you've relied on the set of
17 documents as put together by plaintiffs'
18 counsel --
19 A Yes.
20 Q -- for your opinions?
21 MS. O'DELL:
22 Object -- object to the form.
23 MR. FROST:
24 Q And you have no way of knowing --

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1 right? -- if you've received every document that
2 would be responsive to any of the requests you
3 made?
4 A Based on the Bates numbers, I would say
5 that -- that -- that there's -- that I've -- I've
6 looked at maybe a few percent of the documents
7 that are somehow entered into this. And, so, I
8 can't say that -- that Imerys 436182 wouldn't
9 have something relevant.
10 Q Uh-huh.
11 A But I may not have seen it. It may not
12 have been screened by the -- by the lawyers and
13 deemed something that they should send to me.
14 Q Okay.
15 A So I don't really know.
16 Q I was gonna say, that -- that's sort of
17 what I'm getting at. What I'm getting at is
18 you -- you have no way of knowing one way or the
19 other whether or not what you were provided in
20 response to your request for documents is a
21 complete set of all documents on those topics;
22 correct?
23 MS. O'DELL:
24 Object to the form.

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1 A I was told that -- that, relative to
2 this material here, that what I've got is what --
3 is what they received after their request.
4 MR. FROST:
5 Q All right. And you have no way of
6 verifying whether or not what they sent you was
7 just a collection of documents that they had
8 culled through that --
9 MS. O'DELL:
10 Object --
11 MR. FROST:
12 Q -- justifies their opinions and their
13 positions in this case?
14 MS. O'DELL:
15 Object to the form.
16 A I would have -- I don't know how
17 anybody would know the answer to that. I mean,
18 no.
19 MR. FROST:
20 Q Okay.
21 A I mean, I've not had access to every
22 document involved in this case, so I have no --
23 no idea.
24 Q Okay. Do you think, as an expert

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1 giving opinions regarding some of the mining and
2 sampling practices -- for example, of Imerys and
3 Johnson & Johnson -- that it would be important
4 to have a complete set of all data and
5 information before rendering those opinions?
6 MS. O'DELL:
7 Object to the form.
8 A My opinions are based on the material
9 that was supplied to us after we asked.
10 MR. FROST:
11 Q Okay. So if there were additional
12 materials, you know, that either contradict or
13 are different than some of the materials you've
14 seen, would you look at and view those with an
15 open mind?
16 A Absolutely. I mean, that's the way I
17 started this, and that's the way we're gonna end
18 it.
19 Q And, again, if there were documents
20 that potentially refuted some of your opinions,
21 yeah, you would look at those and be willing to
22 either adjust or change your opinions based on
23 those documents?
24 A Well, I -- I looked at this as a -- as

<p style="text-align: right;">Page 38</p> <p>1 an exercise in the application of the scientific 2 method. And, so, that -- that requires you to 3 continue to test what you have opinion on. But 4 it looks like, based on everything that I've -- 5 I've been given, that -- that there's pretty -- 6 pretty solid support for the opinions I've made 7 so far. But -- but I would be more than willing 8 to look at additional data, for sure. 9 Q And, for example, you know, you note 10 with respect to, say, sampling and testing that 11 there appears to be hundreds, if not thousands, 12 of tests that are missing from the documents 13 you've looked at. Is that correct? 14 MS. O'DELL: 15 Object to the form. 16 A That -- that would be my -- that -- 17 that could be an opinion, yes. It -- because 18 there's description of samples that are taken 19 here, there, and everywhere and in certain time 20 periods, and then -- but you look for the results 21 of the analyses, and they aren't there. 22 MR. FROST: 23 Q Okay. 24 A So, yeah, I'm sure.</p>	<p style="text-align: right;">Page 40</p> <p>1 today, have you reviewed any other depositions to 2 prepare for this case? 3 MS. O'DELL: 4 Object to the form. I don't think he's 5 mentioned a Dr. -- there's not -- I'm not aware 6 of a Downey -- 7 MR. FROST: 8 Oh, is he not a doctor? 9 MS. O'DELL: 10 -- witness in this case. 11 MR. FROST: 12 Oh, okay. 13 MS. O'DELL: 14 I don't think -- he's a doctor, but I 15 don't think he mentioned him. 16 MR. FROST: 17 Okay. 18 MS. O'DELL: 19 So you might ask an open-ended 20 question. 21 Or, if you understand it, please -- 22 A I -- I understand what you're asking. 23 MR. FROST: 24 Q Sure.</p>
<p style="text-align: right;">Page 39</p> <p>1 Q So you agree with me it looks like, 2 you know, you don't have the complete set of 3 testing data, for example? 4 MS. O'DELL: 5 Object to the form. 6 A I would say that -- that it may be that 7 I have everything that's available. It may be 8 that a lot of these results don't exist in 9 anybody's files anymore. 10 MR. FROST: 11 Q But you can't tell me one way or the 12 other, without speculating, as to whether or not 13 any of those additional testing samples, testing 14 documents, records, et cetera, exist in the 15 documents produced by the two companies in this 16 case and just weren't provided to you by counsel; 17 correct? 18 A I have no idea. 19 Q Okay. Now, you had talked about a 20 couple of the depositions. I also note in your 21 report I think you -- you referenced the 22 deposition of Mr. -- or Dr. Downey in your 23 report. Other than what you've disclosed in -- 24 in the report and the three you've talked about</p>	<p style="text-align: right;">Page 41</p> <p>1 A There's a list of depositions that I -- 2 I have looked at that's in this list of materials 3 considered. 4 And there's Hopkins. It's footnoted in 5 my report. 6 Julie Pier, I've looked at hers. 7 I've looked at Alice Blount's. 8 There's one that I looked at a long 9 time ago. I can't -- can't even remember the 10 person's name, and it -- it had little relevance 11 to what we're doing. 12 Hopkins, Downey, Blount, Glassley, 13 which I mentioned. 14 There may -- I think there's at least 15 one more that's -- that's actually in my list of 16 materials considered. 17 Q Okay. But it would be -- it would -- 18 it would be listed in the materials considered? 19 A Yes. 20 Q It's just the three, the Gunter, 21 Sanchez and Gassley, that -- 22 A Glassley. 23 Q -- weren't listed? 24 Glassley?</p>

<p style="text-align: right;">Page 42</p> <p>1 MS. O'DELL: 2 I think Glassley was listed. 3 MR. FROST: 4 Oh, was he? 5 MS. O'DELL: 6 Yeah. 7 MR. FROST: 8 Q Have you reviewed any of the 9 depositions of the other experts in this talc 10 MDL? 11 A I don't know. 12 Oh, the depositions? 13 Q Yes. 14 A I'm not sure about who was -- 15 When you say the MDL -- 16 Q In this particular case. 17 A Oh. 18 Q Any of the other experts from 19 plaintiffs' counsel in this case? 20 A I think we've got them listed. 21 Q Have -- other than the -- 22 I'll ask this a different way. We've 23 been taking depositions of various plaintiffs' 24 experts for the past about month.</p>	<p style="text-align: right;">Page 44</p> <p>1 Q And you've reviewed these while they 2 were in draft form? 3 MS. O'DELL: 4 Object to the form. 5 A I don't know whether they were draft 6 form or not. They were -- they were in good 7 shape in terms of grammar and punctuation. I 8 would have -- I would have certainly thought they 9 were close to final. 10 MR. FROST: 11 Q Did you review these prior to 12 finalizing your initial report? 13 A No. 14 Q Have you reviewed these after the 15 initial report? 16 A Yes. 17 Q Did you review these before the -- 18 issuing the second report? 19 A Yes. 20 Q The amended? 21 In reviewing the -- the Smith, 22 Zelikoff, Campion, and Krekeler reports, did that 23 at all influence any of the opinions or any of 24 the analysis you did in the amended report?</p>
<p style="text-align: right;">Page 43</p> <p>1 A Uh-huh. 2 Q Have you seen or read any of those 3 transcripts? 4 A No. 5 Q Okay. And you're aware that plaintiffs 6 served other expert reports, like yours, in -- in 7 November? 8 A Yes. 9 Q And then some in January? 10 A Yes. 11 Q Have you reviewed any of those reports? 12 A I looked at a -- a draft of Krekeler 13 and Campion. I'm assum- -- I don't know whether 14 he's been deposed or not. And there were -- 15 there were two others who were really related to 16 generating summaries of published literature. 17 But Campion's was interesting since it was a 18 Raman spectra deposition or expert report. 19 Q Do you recall who the other two were? 20 A No. Believe it or not, one of them's 21 name was Smith, and the other one had a foreign 22 name. 23 Q Would that be Dr. Zelikoff? 24 A Yes.</p>	<p style="text-align: right;">Page 45</p> <p>1 A It did not. I -- I was a little bit 2 intrigued with the Campion, the Campion report. 3 It made me think that that was a field of 4 potential research. I didn't realize that -- 5 that the Raman approach could be as useful as it 6 might be. 7 Q Was this more a, you know, sort of 8 piqued your interest or personal curiosity -- 9 A Yeah. Right. 10 Q -- as opposed to the opinions you're 11 rendering in this case? 12 A Yes. 13 Q I take it you've done work with Raman's 14 spectrograph? 15 A I have sort of steered clear of it. We 16 didn't have a machine on campus, and so I 17 didn't -- I wasn't as familiar with it as I 18 probably should have been. And then I read his 19 report, and I -- and it's pretty interesting. 20 Q And you noted that you looked at a 21 draft of Krekeler's report. 22 A Correct. 23 Q Did you have any comments to that 24 draft?</p>

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1 A There were two drafts that I looked at.
 2 I looked at an early one and a final one. The --
 3 the -- the parts that I thought were --
 4 MS. O'DELL:
 5 Dr. Cook --
 6 THE WITNESS:
 7 Yes.
 8 MS. O'DELL:
 9 -- To the degree that you're -- that
 10 there were any discussions, those are not
 11 something that I -- I would instruct you not to
 12 testify to discussions --
 13 THE WITNESS:
 14 I understand.
 15 MS. O'DELL:
 16 -- with plaintiffs' counsel.
 17 THE WITNESS:
 18 Understand.
 19 I felt that they were in depth and --
 20 and that -- that what he had to say was -- was
 21 good in -- in a lot of areas.
 22 MR. FROST:
 23 Q Okay. Do you offer any comments to
 24 Dr. Krekeler's report?

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1 A In -- like in writing?
 2 MS. O'DELL:
 3 Same instruction.
 4 THE WITNESS:
 5 Yeah.
 6 Not really.
 7 MR. FROST:
 8 Q Okay. By "not really," does that mean
 9 that, you know, none as far as writing and
 10 content, or did you have some comments in the
 11 report that you then conveyed?
 12 A Well, I mean, if you're gonna read
 13 something, so -- you're gonna end up discussing
 14 it in some way. You know, if you don't, then
 15 why -- why bother reading it if it's not gonna
 16 enter into the bigger picture?
 17 But -- but, no. I mean, I wasn't -- I
 18 wasn't asked to sit down and carefully critique
 19 either one of those reports. And I certainly
 20 think that he -- he pointed out some important
 21 things that -- that -- that should be considered.
 22 Q Do you know why you were asked to
 23 review drafts of Dr. Krekeler's report?
 24 A No. But -- but I think that it may be

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1 because I work closely with a man named
 2 John Rakovan, who is probably his boss. He's
 3 a -- John is also a professor at Miami of Ohio.
 4 And I had -- when they were considering Krekeler,
 5 I -- you know, I checked -- checked with John
 6 Rakovan about him, and he got a nice clean bill
 7 of health. So I kind of knew who he was going
 8 into this.
 9 Q Did you offer any written comments --
 10 A No.
 11 Q -- to either of the two drafts?
 12 A I don't think I did.
 13 Q Okay. Did you discuss any comments to
 14 the drafts with plaintiffs' counsel?
 15 A I probably did.
 16 Q Do you remember what areas of his
 17 report those comments would have been about?
 18 A They were -- I think that they weren't
 19 really about areas of his report. They were --
 20 they were more about he's gone into great detail
 21 here. Probably it's, you know, irrelevant, he
 22 needs to shorten it, that type of thing.
 23 I looked at his report as if I was
 24 looking at a student's report and what I would do

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1 to, you know, to make it easier to read, more
 2 understandable. I mean, I thought that he --
 3 that his first draft was -- was probably way more
 4 than was needed.
 5 Q And other than grammatical things and
 6 things that relate to length, did you have any
 7 substantive comments about the contents of his
 8 report?
 9 A I liked -- I liked --
 10 MS. O'DELL:
 11 Dr. Cook, to the degree that those
 12 comments were discussions that you had with me --
 13 THE WITNESS:
 14 Right.
 15 MS. O'DELL:
 16 -- or plaintiffs' counsel, they're not
 17 entitled to ask you that question, and, so, I'm
 18 instructing you not to convey those comments.
 19 THE WITNESS:
 20 Okay.
 21 MR. FROST:
 22 We disagree. And you can raise it, but
 23 we think, you know, any communications between
 24 experts, including whether they're filtered

<p style="text-align: right;">Page 50</p> <p>1 through counsel or not, are subject to 2 disclosure. But we can deal with that at a later 3 time if you're instructing him not to answer. 4 THE WITNESS: 5 Yeah. 6 MS. O'DELL: 7 And to the -- 8 Excuse me. 9 To the degree that there is a comment 10 that you've made to me or -- or other plaintiffs' 11 counsel, then -- then that's something that I'm 12 instructing you not to testify to. 13 THE WITNESS: 14 Right. 15 MS. O'DELL: 16 So if there's -- so -- 17 THE WITNESS: 18 You're not asking if I've had direct 19 contact with Krekeler, are you? 20 MR. FROST: 21 Q Asking that next, but -- 22 A Well, I haven't. 23 Q Okay. 24 A And -- and I personally think that</p>	<p style="text-align: right;">Page 52</p> <p>1 Q So there's no reason to flip through 2 Exhibit 1 at this point. Exhibit 2 -- 3 A No. 4 Q -- contains your opinions. 5 Okay. If you could turn to page 38 of 6 your amended report at the very bottom. 7 A Okay. Okay. Got it. 8 Q I take it this is the reference you're 9 talking about, the "normally expected failure or 10 rejection rates were not observed, as discussed 11 in detail in the expert report of Krekeler 12 (2018)? 13 A That's correct. 14 Q Okay. And I take it, other than this 15 reference, you know, you yourself have no 16 opinions about the -- whether or not failure 17 rejection rates were correct? You're deferring 18 to Krekeler for that? 19 A I'm deferring to him. I have an 20 opinion, you know, but I don't -- I don't have 21 the strength of knowledge to support my opinion. 22 Q Okay. 23 A But I defer to him because I believe he 24 does.</p>
<p style="text-align: right;">Page 51</p> <p>1 there was some -- some important things that he 2 pointed out. And whether or not I mentioned them 3 to Miss O'Dell or not, I don't know. But I 4 certainly, in reading his final draft, I thought 5 there were some interesting things in there. 6 They weren't things that I had addressed myself, 7 and I thought they were good. 8 Q Is there anything in the Krekeler 9 drafts that you included in your report because 10 you had read through his? 11 A I only mentioned and actually deferred 12 to him the concept of sampling frequency, the -- 13 the expected failure rate of samples that -- 14 He had references to all of that and 15 pointed out that that seemed to be something 16 that -- that was contrary to expectation. And, 17 so, I pointed that out. But I refer completely 18 to him. 19 Q If you turn -- 20 Actually, this is a good point. I take 21 it by -- I take it your intention was that the 22 amended report in Exhibit 2 would take the place 23 of the original report in Exhibit 1? 24 A Yes.</p>	<p style="text-align: right;">Page 53</p> <p>1 Q Yeah. So you haven't done any 2 independent statistical analysis or anything like 3 that regarding rejection rates? 4 A No. 5 Q Do you believe there's anything in your 6 report that you accidentally copied from a site 7 that you didn't either put quotes around or put a 8 proper citation to? 9 A I hope not. I mean, there could be, 10 but I would hope that there wouldn't be. 11 Q If you turn to page 9 of your report. 12 Specifically, I'll direct your attention to 13 Footnote 12. 14 A Okay. 15 Q Do you know where you got this 16 information from? 17 A This was probably pulled out of perhaps 18 AGI glossary or one of the -- one of the AIME 19 references. 20 Q Are you familiar with the website of a 21 company called Rishabh Metals & Chemicals? 22 A No. 23 Q I'll mark this as Exhibit 6. 24 I believe we're on 6; right?</p>

<p style="text-align: right;">Page 54</p> <p>1 THE COURT REPORTER:</p> <p>2 Yes, we are.</p> <p>3 (DEPOSITION EXHIBIT NUMBER 6</p> <p>4 WAS MARKED FOR IDENTIFICATION.)</p> <p>5 MR. FROST:</p> <p>6 Q I'd like to turn your attention to what</p> <p>7 is on the printout -- 1, 2, 3, 4, 5, 6 -- page 7.</p> <p>8 A I'm not sure that I haven't seen this</p> <p>9 on the Internet.</p> <p>10 Q If you look under "or beneficiation."</p> <p>11 A Sure.</p> <p>12 Q And do you agree with me that what's in</p> <p>13 the report appears to be a quote --</p> <p>14 A Sure.</p> <p>15 Q -- from this website?</p> <p>16 A It'd be nice to know where they got</p> <p>17 their definition. Seriously.</p> <p>18 Q Okay. But do you believe that you saw</p> <p>19 this website while you were drafting your report?</p> <p>20 A You know, when you -- when you</p> <p>21 mentioned the name, it didn't ring a bell. But I</p> <p>22 believe I have seen this.</p> <p>23 Q Okay.</p> <p>24 A But I don't -- I don't know the</p>	<p style="text-align: right;">Page 56</p> <p>1 the things in the table I described -- you know,</p> <p>2 every single reference I had described verbally.</p> <p>3 And then when I saw the table that was being</p> <p>4 prepared, I guess, in Hopkins, it was pretty</p> <p>5 clear that, oh, my God, this is -- you know, I</p> <p>6 need to do this with -- with every data set, go</p> <p>7 ahead and make tables.</p> <p>8 And, so, Beasley Allen folks helped</p> <p>9 construct the -- I guess it was an Excel table.</p> <p>10 Q These are the tables that are --</p> <p>11 A Yeah. But that's it. Everything else</p> <p>12 is -- is --</p> <p>13 And if -- I'm just thinking about the</p> <p>14 Zelikoff thing. I did get a -- I did get a</p> <p>15 reference out of hers. But that's all I</p> <p>16 remember.</p> <p>17 Q Okay. And by "the tables," you're</p> <p>18 referring to the various tables that appear --</p> <p>19 you know, some start on page 13.</p> <p>20 A The tables have replaced very long</p> <p>21 paragraphs that describe each one of these -- for</p> <p>22 the most part, each one. Some of them, the ones</p> <p>23 from the Hicks -- not Hicks -- the Hopkins depo,</p> <p>24 some of those I didn't have until I got his depo.</p>
<p style="text-align: right;">Page 55</p> <p>1 company.</p> <p>2 Q All right. Mark this as Exhibit 7,</p> <p>3 please.</p> <p>4 (DEPOSITION EXHIBIT NUMBER 7</p> <p>5 WAS MARKED FOR IDENTIFICATION.)</p> <p>6 MR. FROST:</p> <p>7 Q Do you recognize this as the expert</p> <p>8 report of Dr. Judith Zelikoff that you reviewed?</p> <p>9 A I only have it online.</p> <p>10 Q Okay.</p> <p>11 A But I'm assuming it is the same.</p> <p>12 Q Okay. If you could please turn to page</p> <p>13 31 of your report.</p> <p>14 A Of my --</p> <p>15 I'm sorry. I'm going to hers.</p> <p>16 Q And I guess I'll start here. Did</p> <p>17 anybody help you write your report?</p> <p>18 A No.</p> <p>19 Q You wrote all of it yourself?</p> <p>20 A Every word. There was help with --</p> <p>21 with the tables. My report was table-less</p> <p>22 initially.</p> <p>23 Q Okay.</p> <p>24 A And it was extremely cumbersome because</p>	<p style="text-align: right;">Page 57</p> <p>1 Q Okay. Did you put together the tables</p> <p>2 or was that something that Beasley Allen --</p> <p>3 A No. They helped.</p> <p>4 Q -- put together for you?</p> <p>5 A They helped.</p> <p>6 Q And I take it, when they sent you the</p> <p>7 tables, it sounds like there were additional</p> <p>8 references in there that originally you didn't</p> <p>9 have or didn't review?</p> <p>10 A There -- there were not.</p> <p>11 Q Okay.</p> <p>12 A I don't think that there were. The</p> <p>13 ones that -- that were related to the Hopkins</p> <p>14 exhibits, I had them, but I think I got them</p> <p>15 after I had prepared my first draft, something</p> <p>16 like that. And so they are -- they were new, new</p> <p>17 to the second edition.</p> <p>18 Q Were there any references when you</p> <p>19 reviewed the tables that you hadn't seen prior to</p> <p>20 the tables being generated by Beasley Allen?</p> <p>21 A I don't think so. I didn't -- I -- I</p> <p>22 didn't notice any. But there are like a</p> <p>23 hundred-and-something references just in the</p> <p>24 table that deals with asbestos.</p>

<p style="text-align: right;">Page 58</p> <p>1 Q And, so, I compared the -- you know, 2 the report in Exhibit 1 to the report in Exhibit 3 2. It looks like a lot of the changes that were 4 made were within the tables. Does that sound 5 correct? 6 A It -- there could have been, sure. 7 Q What type of changes were made to 8 Table -- 9 Well, strike that. 10 Did -- were these changes that you made 11 or were these changes that were made by Beasley 12 Allen? 13 A I went through the table in one and 14 found a goodly number of things that I thought 15 were wrong, but they were -- some of them were 16 spellings that were related to probably 17 spellchecker, like the word "Cyprus" for Cyprus 18 Corporation was misspelled a number of times. 19 There were some incidences where I 20 questioned whether the right terminology was used 21 for mineralogy, for a mineralogical citation. 22 And, you know, we keep going back 23 through these tables, and there's -- I think 24 there may be one sample in the asbestos that may</p>	<p style="text-align: right;">Page 60</p> <p>1 A I think so. 2 Q -- report? 3 Okay. So these weren't new lists that 4 were sent to you by Beasley Allen? 5 A No. No, no. 6 Q And have you reviewed all of the 7 documents that are in each of the charts? 8 A I think I have. 9 Q And I note that your charts are -- I'm 10 not gonna say exactly the same, because, 11 actually, your amended ones change some of the 12 language, but they're materially similar to those 13 showing up in the report of Dr. Krekeler. Have 14 you had a chance to review the charts in his 15 reports? 16 A I've seen a version. I don't know 17 whether it was his latest version. And, yeah, 18 he -- he had -- I mean, that was the whole idea. 19 We've got -- now we've got charts to replace long 20 paragraphs. And, so, they should be similar. 21 Q Okay. And this was the work done by 22 Beasley Allen? 23 A In terms of -- 24 MS. O'DELL:</p>
<p style="text-align: right;">Page 59</p> <p>1 not actually be a cosmetic -- or in the talc that 2 may not be a cosmetic talc. 3 Q Okay. Do you -- do you recall which 4 one that would be or -- 5 A No. 6 Q -- do you have the ability to identify? 7 Okay. 8 A It was a -- it had a number. It was a 9 numerical sample number. 10 Q And were these changes, then, that you 11 made to the -- 12 A I don't think -- 13 Q -- charts that were prepared? 14 A I don't think -- they were intact, and 15 I didn't notice that until a day or two ago. 16 Q Okay. The other changes that were made 17 between the original report and the amended 18 report, were these changes that you made in going 19 through the original report and correcting the 20 spellings? 21 A Tried to, yes. 22 Q Okay. And are you the one who made all 23 of the changes to the reports that show up now in 24 the amended --</p>	<p style="text-align: right;">Page 61</p> <p>1 Object to the form. 2 A Right. In terms of the compilation of 3 the charts, I mean, I'm pretty sure a secretary 4 did it. 5 MR. FROST: 6 Q Okay. And then they sent it to you for 7 inclusion in the report? 8 A Yes. 9 MS. O'DELL: 10 Object to the form. 11 MR. FROST: 12 Q All right. So turning to page 31 of 13 your report. 14 A Yes. 15 Q See the paragraph at the top of 31, it 16 says -- it's starts with the "According to J&J's 17 corporate representative." 18 A Right. 19 Q Do you know where you got this 20 information from? 21 A Yes. 22 MS. O'DELL: 23 Which one are you -- 24 MR. FROST:</p>

Page 62	Page 64
<p>1 The top paragraph in 31, the "According 2 to J&J's corporate representative." 3 A I think that that's in a deposition. 4 Q Can you turn to page 11 of 5 Dr. Zelikoff's report? 6 A Okay. 7 Q Third paragraph down, starts "According 8 to Johnson & Johnson's corporate representative." 9 A Right. 10 Q And I'll just let you review the two. 11 Do you agree with me that these two paragraphs 12 are almost exactly the same? 13 MS. O'DELL: 14 Object to the form. 15 A Well, I can tell you that I wrote mine 16 before she wrote -- or before I ever saw hers. 17 MR. FROST: 18 Q Okay. 19 A So, you know, if they're similar, okay. 20 But, you know, I didn't receive hers until maybe 21 a month ago. 22 Q Okay. So you certainly would -- didn't 23 read and rely on Dr. Zelikoff -- 24 A No.</p>	<p>1 Q -- or the one preceding it that we 2 talked about? 3 A No. 4 Q I'm gonna show you one more on page 34 5 of your report, please. Do you see the paragraph 6 that's above "Cobalt"? 7 A Yes. 8 Q Okay. And then the paragraph right 9 above that, I think it's the second-to-last 10 sentence, starts "Interestingly, there is 11 significant difference between." 12 A Okay. 13 MS. O'DELL: 14 I'm sorry. Where -- where are you, 15 Jack? Excuse me. 16 MR. FROST: 17 It's page 34, so it's the full 18 paragraph above "Cobalt" and then the last two 19 sentences in the paragraph above that. It 20 starts, "Interestingly, there is significant 21 difference." 22 MS. O'DELL: 23 Okay. 24 MR. FROST:</p>
Page 63	Page 65
<p>1 Q -- in order to draft your -- your 2 portion of the report? 3 A No. 4 Q If you can turn to page 32 of your 5 report, the second paragraph that says -- starts 6 "Talc mine in Vermont." 7 A Okay. 8 Q Okay. Again, if you can look at 9 Dr. Zelikoff's page 11. 10 A Okay. 11 Q And it's the fourth paragraph down. If 12 you can read those two. 13 Do you agree with me that they're 14 almost exactly the same again? 15 A Yep. 16 MS. O'DELL: 17 Object to the form. 18 MR. FROST: 19 Q And, again, you weren't relying on 20 Dr. Zelikoff to draft your report? 21 A No. 22 Q And plaintiffs' counsel didn't provide 23 you this paragraph -- 24 A No.</p>	<p>1 Q Okay. And looking back again at pages 2 11 and 12 of Dr. Zelikoff's report -- 3 A That's interesting, because this is 4 a -- something that was in my original report. 5 Q Okay. Yeah. I was gonna say, 6 actually, I -- I will say all of this information 7 was in your original report. 8 A Yeah. I mean, I -- maybe she got ahold 9 of it. I don't know. 10 Q Okay. 11 A But I certainly didn't take anything 12 out of hers. 13 Q All right. And you'd agree with me, if 14 you look at page 11 to 12 -- 15 A Right. 16 Q -- again, the same language -- 17 A Right. 18 Q -- shows up? 19 MS. O'DELL: 20 Object to the form. 21 MR. FROST: 22 Q Okay. And -- 23 MS. O'DELL: 24 Excuse me. Just give me a minute --</p>

<p style="text-align: right;">Page 66</p> <p>1 not a minute, actually -- a second to object if I 2 need to. 3 THE WITNESS: 4 I'm sorry. 5 MS. O'DELL: 6 No worries. 7 MR. FROST: 8 Q So you certainly didn't take 9 Dr. Zelikoff's report to draft yours; correct? 10 A Certainly not. 11 Q And the -- the language in these 12 various paragraphs I pointed out weren't provided 13 to you by plaintiffs' counsel? 14 A No. 15 Q Okay. And you don't know how they 16 ended up in Dr. Zelikoff's report? 17 A I have no earthly idea. 18 Q Okay. Thank you. I'm done with 19 Dr. Zelikoff's. You can put that to the side. 20 I will say, may as well keep your -- 21 As we go through today, I'm sort of 22 going to reference your report. 23 A Sure. 24 Q So you may as well keep Exhibit 2 close</p>	<p style="text-align: right;">Page 68</p> <p>1 of -- of the Italian talc deposits. 2 Q Okay. 3 A And -- and, you know, and that was an 4 interesting search. There is new -- there is new 5 data. 6 Q Do you remember where you searched for 7 the geology of the Italian deposit? 8 A It was just Google searches. Putting 9 in Val Chisone or Val Germanasca talc, You -- you 10 begin to get lots of hits. And there -- there 11 are a couple of recent papers that are pretty 12 good. 13 Q And I believe -- I think you cite 14 Mindat.org? 15 A Yes. 16 Q And that's -- that's the types of 17 things you were searching through on the 18 Internet? 19 A Well, Mindat.org is -- that's sort of 20 an interesting website. It -- it originated in 21 Poland, and the amount of work that's gone into 22 that is -- is unbelievable, because there's only 23 a couple of guys that did this. 24 And the value of Mindat.org is that,</p>
<p style="text-align: right;">Page 67</p> <p>1 by -- 2 A Okay. 3 Q -- as we'll be walking through that as 4 the day progresses. 5 A Okay. 6 Q And we had already talked about it 7 before, but it seems like you did -- is it fair 8 to say that you did investigation of your own 9 library to find some of the reference material 10 you cite in your report? 11 A Yes. 12 Q Other than looking through your 13 physical library, did you do any other type of 14 research? Did you go to a research library, 15 Internet, anything like that? 16 A For the most part, there was no reason 17 to. I've got a complete set of American 18 Mineralogist back to day one, complete set of 19 Economic Geology to day one, complete set of 20 Bibliography of North American Geology. And 21 everything that the USGS has done, I have a copy 22 of. I mean, I had 5,000 books. 23 And, so, the only thing I really -- I 24 really did on the Internet was search for geology</p>	<p style="text-align: right;">Page 69</p> <p>1 for many of the localities where they'll 2 attribute a mineral to, they'll list the 3 reference. So it's a darn good place to go find 4 references. 5 Q It's a great place to start? 6 A Yeah. It's a really good place to 7 start. And -- and they've won awards, worldwide 8 awards, for that particular site and the amount 9 of work they've had to put into it. 10 Q And you've already told me nobody 11 helped you draft your report. Did anybody help 12 you do the research? 13 A No. 14 Q You didn't use any graduate students 15 or -- 16 A No. No. No, no, no. 17 Q Okay. All right. And we -- we've 18 covered a little bit of this, but your 19 background, do you consider yourself a geologist, 20 a mineralogist? What -- how do you define your 21 expertise? 22 A Well, you know, I started out as a 23 mining engineer. So my original educational 24 background was in mining engineering. And then I</p>

<p style="text-align: right;">Page 70</p> <p>1 was lucky enough to get to go on in graduate 2 school at Georgia in geology. And, so, I'm 3 really both. I'm a mining engineer. I'm not a 4 registered engineer. I should have gone ahead 5 and done that, but I didn't. But I am, of 6 course, a registered geologist in -- in a number 7 of states.</p> <p>8 Q I was gonna say, I believe you're 9 registered in Georgia, Florida, and Alabama?</p> <p>10 A Right. Those are the -- the three good 11 ones.</p> <p>12 Q All right. And you're not a medical 13 doctor; correct?</p> <p>14 A I'm -- I'm certainly hoping I'm not.</p> <p>15 Q Right?</p> <p>16 A No, I'm not.</p> <p>17 Q And you're not a toxicologist?</p> <p>18 A No.</p> <p>19 Q And you don't hold a degree in either, 20 you know --</p> <p>21 Medical doctor is a terrible way, but 22 you don't hold an M.D. or a degree as a 23 toxicologist; correct?</p> <p>24 A No. No.</p>	<p style="text-align: right;">Page 72</p> <p>1 fines, MSHA fines, I'm probably an expert.</p> <p>2 Q Okay. Have you ever done any -- any 3 research or publication regarding mine 4 regulations?</p> <p>5 A In terms of research, yes. But -- but 6 in a practical sense, I mean, I -- I have an 7 interest in three operating mines, so -- so I 8 have to try to stay on top of this.</p> <p>9 Q Okay. Have you ever participated in 10 the regulatory process either with, you know, the 11 SEC, JORC, any of the other regulatory agencies?</p> <p>12 A No. But I have tried to supply 13 students to the regulatory agencies, and -- and I 14 have a number that -- that are -- are pretty high 15 up. One of mine is very high up in EPA right 16 now. And I am kind of proud of them. I've got 17 three or four that are really doing well.</p> <p>18 Q Okay. But you yourself have never --</p> <p>19 A Well --</p> <p>20 Q -- been part of that process?</p> <p>21 A Well, they send me consulting work.</p> <p>22 Q Okay.</p> <p>23 A Why do you think I pointed them in that 24 direction?</p>
<p style="text-align: right;">Page 71</p> <p>1 Q And you have no formal training in 2 either what I'll call human medicine or 3 toxicology?</p> <p>4 A No.</p> <p>5 Q Do you consider yourself a regulatory 6 expert?</p> <p>7 A 40 CFR is -- I mean, I -- I understand 8 some of it, and I've certainly worked with it.</p> <p>9 When -- when the RCRA law first came 10 out, I was -- I was into that very deep. And 11 today, probably not, except in very specific 12 areas.</p> <p>13 Q Would one of -- do you consider your -- 14 yourself an expert in the regulatory process of 15 talc mining or talc ore?</p> <p>16 A I'm not sure that -- that there really 17 is a regulatory issue related to talc mining that 18 -- that's unique. There are certainly 19 regulations related to that type of mining, and I 20 -- I'm familiar with them.</p> <p>21 Q Okay. Is it just a familiarity, or 22 would you consider yourself an expert in the -- 23 the regulations regarding that type of mining?</p> <p>24 A In that I have had to suffer through</p>	<p style="text-align: right;">Page 73</p> <p>1 Q Well, sure.</p> <p>2 Other than sending you consulting work, 3 you know, you've never testified before any of 4 the bodies or --</p> <p>5 A Well --</p> <p>6 Q -- given any comments --</p> <p>7 A -- I've testified relative to, 8 you know --</p> <p>9 Yes, I've testified relative to 10 litigation in terms of the mining impact on 11 private properties.</p> <p>12 Q Okay. Have you ever testified at any 13 of the hearings regarding regulations or 14 commented on the regulatory process?</p> <p>15 A The only one that I formally commented 16 on was the SOAP program, which was called the -- 17 the Small Operator Assistance Program, that was 18 put in place probably in the late '70s. And it 19 may not even exist anymore. But it was a way 20 that small mining companies could get federal 21 assistance so that they -- they were able to 22 comply with new environmental regulations. And I 23 actually participated in that.</p> <p>24 Q Okay. Have you ever formally commented</p>

<p style="text-align: right;">Page 74</p> <p>1 on any regulations regarding, you know, for</p> <p>2 example, requirements of drilling, requirements</p> <p>3 of sampling and compositing, anything of that</p> <p>4 nature?</p> <p>5 MS. O'DELL:</p> <p>6 To regulatory agencies?</p> <p>7 MR. FROST:</p> <p>8 Q To regulatory agencies.</p> <p>9 A I've had discussions with regulators.</p> <p>10 Q But no formal comments?</p> <p>11 A No, no.</p> <p>12 Q Have you ever worked with talc before?</p> <p>13 A Yes.</p> <p>14 Q When was that?</p> <p>15 A Well, first thing I ever did with talc</p> <p>16 was to get money to live on. I sold talc when I</p> <p>17 was between my -- my graduation date at the</p> <p>18 School of Mines and when I started at Georgia.</p> <p>19 There was a company that was trying to</p> <p>20 buy talc to put into kits that they were selling,</p> <p>21 mineral kits. And, so, they -- they sent me a</p> <p>22 list of materials they wanted, and talc was right</p> <p>23 at the top.</p> <p>24 So I knew some of the talc locations in</p>	<p style="text-align: right;">Page 76</p> <p>1 So, from that standpoint, I have a</p> <p>2 pretty good background into the geology of that</p> <p>3 type of talc occurrence, keeping in mind that</p> <p>4 that isn't the only type.</p> <p>5 Q Uh-huh.</p> <p>6 A But I have done work for companies that</p> <p>7 are exploring for talc.</p> <p>8 In fact, I just recently -- I -- I had</p> <p>9 to relog some drill core and redo some thin</p> <p>10 sections for a company that -- that had</p> <p>11 undertaken a talc project as a consultant and</p> <p>12 then they were unable to do it. They -- they</p> <p>13 weren't sure what they were doing.</p> <p>14 You know, we -- I'm sure we'll mention</p> <p>15 Alice Blount. She -- she was interested in the</p> <p>16 talc deposits at Winterboro, Alabama, and I had</p> <p>17 drilled them with a -- a company and had also</p> <p>18 designed an exploration program for additional</p> <p>19 talc deposits at Winterboro which were carried</p> <p>20 out.</p> <p>21 But Dr. Blount wanted to look at the</p> <p>22 drill core. And -- and I was actually the one</p> <p>23 that pulled the boxes for her and showed her the</p> <p>24 intervals that she wanted to show and -- and</p>
<p style="text-align: right;">Page 75</p> <p>1 Georgia, and so I went and began to pick through</p> <p>2 the mine dumps looking for lumps of talc that</p> <p>3 made it onto the dumps. That was my first</p> <p>4 experience with talc.</p> <p>5 But, since then, it -- it's gone a long</p> <p>6 way. I mean, I'm looking at ultra -- ultramafic</p> <p>7 rocks right now in a project that we actually key</p> <p>8 in on talc and asbestos occurrences. But we're</p> <p>9 looking for nickel and -- and precious metals</p> <p>10 associated with them. And this has grew out of</p> <p>11 some work I did for the US Geological Survey.</p> <p>12 Six of us put together one of their professional</p> <p>13 papers, number 1475, which was a paper that</p> <p>14 discussed the -- the evolution of -- of the</p> <p>15 eastern part of the US, specifically Georgia and</p> <p>16 Alabama.</p> <p>17 But what we came up with was a -- a</p> <p>18 much broader picture that would allow a</p> <p>19 connection all the way up the Eastern Seaboard,</p> <p>20 even into Vermont and on into Canada, that showed</p> <p>21 the relationship of ultramafic rocks to the</p> <p>22 development of the eastern part of the US. And</p> <p>23 that has -- you know, people are still citing it,</p> <p>24 cursing it and citing it.</p>	<p style="text-align: right;">Page 77</p> <p>1 would turn my back when she took a sample, that</p> <p>2 kind of thing. So...</p> <p>3 Q All right.</p> <p>4 A So, anyway...</p> <p>5 And -- and I've been working -- working</p> <p>6 on talc projects all along since -- since I got</p> <p>7 out of school.</p> <p>8 Q Okay. Have you ever published anything</p> <p>9 other than this -- the USGS paper regarding talc?</p> <p>10 A Yes. The -- I wrote the mineralogies</p> <p>11 for both Georgia and Alabama, and there are</p> <p>12 sections on talc in both of those.</p> <p>13 Q And other than the two books you</p> <p>14 published, is there anything else that you</p> <p>15 published, peer-reviewed?</p> <p>16 A I'm absolutely sure that there are.</p> <p>17 I'm -- I'm an executive editor for a magazine</p> <p>18 that publishes Geographic Mineralogy, and I've</p> <p>19 edited many papers dealing, in part, with talc</p> <p>20 for that journal. So...</p> <p>21 But in terms of have I -- have I</p> <p>22 discussed talc in any other papers? I'm sure,</p> <p>23 yes. I mean, you've got my -- my vita.</p> <p>24 Q Uh-huh.</p>

<p style="text-align: right;">Page 78</p> <p>1 A And, I mean, there's a lot of pages in 2 there. I'd have to go through them one by one 3 and think back and, you know, "Did I mention 4 talc?"</p> <p>5 The problem with this is that I've done 6 petrographic work for probably 25 or 30 quarries. 7 And -- and this is done routinely.</p> <p>8 I mean, some of these quarries I've 9 done the work maybe four or five times because 10 they do it ann- -- maybe not annually but maybe 11 every couple of years, just to make sure that 12 their product does not contain asbestos.</p> <p>13 Q Uh-huh.</p> <p>14 A And, so, talc is not that rare of a 15 mineral. And, so, I'm sure that, in some of 16 those reports, I'm -- I'm mentioning, "Yep, 17 you've got .03 percent talc in your product."</p> <p>18 Q I guess a better way to ask this 19 question, have you ever published any literature 20 that expressly focuses on talc, as opposed to 21 just mentioning it within the paper?</p> <p>22 MS. O'DELL:</p> <p>23 So solely on talc.</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 80</p> <p>1 Q I think I've read that amphiboles make 2 up a -- it's a creepy percentage. It's like 10 3 or --</p> <p>4 A I -- I saw that, and I questioned it.</p> <p>5 MS. O'DELL:</p> <p>6 Let him finish, Doctor.</p> <p>7 THE WITNESS:</p> <p>8 Okay.</p> <p>9 MR. FROST:</p> <p>10 Q I was gonna say, have you ever read 11 anything about, you know, sort of how abundant 12 amphiboles are?</p> <p>13 MS. O'DELL:</p> <p>14 Object to the form.</p> <p>15 A Yes.</p> <p>16 MR. FROST:</p> <p>17 Q Okay. Do you agree with me the -- 18 especially throughout the Eastern United States, 19 the Appalachian Belt, things like that, 20 amphiboles are extremely common?</p> <p>21 A They are. They -- they occur generally 22 in belts of rocks. You know, when -- when you 23 see the -- the number that you're referring to, 24 I -- I read that, and I said, "Holy criminy,</p>
<p style="text-align: right;">Page 79</p> <p>1 Q Yes, solely on talc or where talc is 2 one of the main -- it wouldn't be solely, but, 3 you know, where talc is the main focus of the 4 paper or the research.</p> <p>5 A I'm gonna say no, but -- but maybe I 6 might think of one or two --</p> <p>7 Q Okay.</p> <p>8 A -- as we -- as we go along.</p> <p>9 Q If you do, let me know.</p> <p>10 Have you ever published anything 11 regarding amphiboles directly?</p> <p>12 A Yeah. The -- the same story is true 13 there because, I mean, amphiboles are -- are 14 exceedingly common, and I probably -- I probably 15 have 50 publications that deal with amphiboles.</p> <p>16 Q That deal with amphiboles specifically?</p> <p>17 A Yeah. Yeah. They'll be -- well, the 18 problem with amphiboles is they're such a 19 common -- the family is so common that -- that if 20 you're gonna go out in the crystalline rocks of 21 the Eastern US, you're gonna find amphibolites or 22 rocks that contain amphiboles. And, then, if 23 you're gonna write -- write the paper, you -- you 24 describe them.</p>	<p style="text-align: right;">Page 81</p> <p>1 this -- this just can't be right."</p> <p>2 But, then, if -- if you begin to think 3 about the shallow crust, a great -- a large 4 percent of it is really oceanic crust. And 5 amphiboles and related mafic minerals are very 6 common in the oceanic crust. And, of course, 7 that underlies the continents, so...</p> <p>8 Q Have you ever done any testing of talc?</p> <p>9 A In terms of, like, brightness, density, 10 no.</p> <p>11 Q Okay.</p> <p>12 A I -- I've certainly described talc, 13 you know, optically in thin section.</p> <p>14 Q What do you mean by "described" it?</p> <p>15 A You know, if it occurs in a rock, I 16 would describe grain size, relationship to 17 adjacent mineral grains, that type of thing.</p> <p>18 Q Okay. What about amphiboles? Have you 19 ever done any specific testing on amphiboles?</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 A Let me back up. I've x-rayed talc 23 in -- in years past, and I've certainly x-rayed a 24 lot of amphiboles.</p>

<p style="text-align: right;">Page 82</p> <p>1 MR. FROST:</p> <p>2 Q And by "x-ray," are you talking about</p> <p>3 XRF or XRD?</p> <p>4 A XRD.</p> <p>5 Q And was this related to academics, or</p> <p>6 was this related to the work you were doing with</p> <p>7 some of the mining companies?</p> <p>8 A Academics.</p> <p>9 Q And was this for mineral identification</p> <p>10 purposes?</p> <p>11 A Mainly.</p> <p>12 Q Did you ever publish any of your</p> <p>13 mineral identification XRD work on either talc or</p> <p>14 amphiboles?</p> <p>15 A A lot of it is published but without</p> <p>16 reference to the analytical technique.</p> <p>17 I mean, I -- when you're -- when you're</p> <p>18 writing a paper, you can't describe how you</p> <p>19 identified every single mineral grain in every</p> <p>20 single sample. I mean, it's just impossible.</p> <p>21 But it was very common to -- to run</p> <p>22 confirmatory x-ray diffraction analyses on</p> <p>23 samples that we thought we knew what we had.</p> <p>24 "Let's -- let's check and make sure."</p>	<p style="text-align: right;">Page 84</p> <p>1 study for about six or eight of their quarries.</p> <p>2 But they were -- you know, they were concerned,</p> <p>3 like everybody is, is quarrying something out of</p> <p>4 the ground that -- that, you know, when you're</p> <p>5 producing a couple million tons a year out of a</p> <p>6 single hole in the ground in hard rock that's of</p> <p>7 a metamorphic grade that might have asbestos</p> <p>8 minerals, you want to know whether or not you've</p> <p>9 got something.</p> <p>10 Q Okay.</p> <p>11 A And, so, I did the work for Oldcastle,</p> <p>12 and they have a whole series of reports that I</p> <p>13 did for them that -- that outline the absence of</p> <p>14 asbestos.</p> <p>15 Q Okay. And Oldcastle, I looked them up.</p> <p>16 I believe they're a gravel quarry? Is that -- is</p> <p>17 that fair?</p> <p>18 A No.</p> <p>19 Q Okay.</p> <p>20 A They're one of the largest construction</p> <p>21 materials company in the world. They own the</p> <p>22 Bank of Scotland. That's where the word</p> <p>23 Oldcastle comes from. They're a Scottish</p> <p>24 company --</p>
<p style="text-align: right;">Page 83</p> <p>1 Q Do you consider yourself an expert in</p> <p>2 XRD?</p> <p>3 A I would say that I used to be. I could</p> <p>4 just about make a diffractometer jump up and</p> <p>5 dance. Not -- not anymore. There's a whole new</p> <p>6 generation of machines out there that are -- that</p> <p>7 are -- can do things that I never thought would</p> <p>8 ever be done.</p> <p>9 Q And it's just not something -- you</p> <p>10 haven't kept up with the technology or the</p> <p>11 research?</p> <p>12 A No. Actually, they sold my -- I had</p> <p>13 a -- I had my own x-ray machine, and the</p> <p>14 university sold it when I retired because nobody</p> <p>15 knew how to run it. I'm serious. I -- they</p> <p>16 should have never done that.</p> <p>17 Q All right. Have you ever done -- have</p> <p>18 you ever published anything regarding asbestos?</p> <p>19 A Same -- same story. You know, in -- in</p> <p>20 the two state mineralogies, there's lots of</p> <p>21 information I published on asbestos. And I've --</p> <p>22 you know, I've testified relative to asbestos and</p> <p>23 for -- and I'm -- I'm sure that I can say this,</p> <p>24 but for Oldcastle, I did a complete asbestos</p>	<p style="text-align: right;">Page 85</p> <p>1 Q Okay.</p> <p>2 A -- that operate in the US under a lot</p> <p>3 of different names. But -- but the man I did</p> <p>4 this for was David Toolan, who's their general</p> <p>5 counsel in Atlanta. And so I used the word</p> <p>6 "Oldcastle" because he's the Oldcastle general</p> <p>7 counsel.</p> <p>8 Q What type of ores were you looking at</p> <p>9 when you were doing these reviews?</p> <p>10 A What was that?</p> <p>11 Q What type of ores were you looking at</p> <p>12 when you were doing these reviews?</p> <p>13 A Everything they had was being sold for</p> <p>14 aggregate for one use or another. You know,</p> <p>15 there are different uses for aggregate.</p> <p>16 Q Uh-huh.</p> <p>17 A And, so, each one of the quarries was a</p> <p>18 quarry that -- that was crushing and sizing stone</p> <p>19 for either a concrete market, a surface materials</p> <p>20 market.</p> <p>21 A lot of material gets -- gets sold to</p> <p>22 Florida because Florida doesn't have adequate</p> <p>23 rock to surface their own highways. So</p> <p>24 everything that is -- is a good surface material,</p>

<p style="text-align: right;">Page 86</p> <p>1 if it's asphalt in Florida, it's coming out of 2 Georgia or Alabama. 3 Q Okay. So -- 4 A And that's -- that's the type of stuff. 5 Q All right. I apologize. I used the 6 word "gravel." I'm guessing gravel is probably 7 not -- 8 A No. 9 Q -- the right mining term. 10 A I'm very upset with that. 11 Q But I think we're talking about the 12 same thing. 13 A Yeah. 14 Q So aggregate seems to be the correct 15 term. 16 A Aggregate. 17 Q And I apologize. 18 And it seems like your job was to 19 determine -- locate asbestos within that ore, or 20 the absence of it? 21 A Well, it was -- it was a little bit 22 more than that. They had -- I had to go and 23 sample their stockpiles and select samples from 24 the stockpiles to --</p>	<p style="text-align: right;">Page 88</p> <p>1 Q And you've never published anything 2 regarding talcum powder specifically; correct? 3 A No. 4 Q And did you have any opinions 5 regarding, you know, talcum powder and the 6 potential of asbestos or heavy metals in talcum 7 powder prior to being engaged in this litigation? 8 MS. O'DELL: 9 Object to the form. 10 A No. 11 MR. FROST: 12 Q Okay. 13 All right. That's a good place to take 14 a break. 15 VIDEOGRAPHER: 16 Going off the record. The time is 17 10:06 a.m. 18 (OFF THE RECORD.) 19 VIDEOGRAPHER: 20 We're back on the record. The time is 21 10:25 a.m. 22 MR. FROST: 23 Q All right. Let's turn to page 2 of 24 your report. And under the section "Summary of</p>
<p style="text-align: right;">Page 87</p> <p>1 I use a lab in Salt Lake City or in 2 Lindon, Utah, which is south of Salt Lake, to 3 make my -- my -- my thin sections. And, so -- 4 and then I would do complete thin section 5 analysis for each sample. And I would count more 6 or less a thousand grains in each thin section 7 and -- and report on the mineral composition of 8 their rock. 9 Q Uh-huh. 10 A And if there was a -- 11 And some of them actually have 12 amphiboles. But, with one exception, I never saw 13 anything that I would have -- I would have, you 14 know, said this is a -- you know, you're looking 15 at some chrysotile or something like that. I did 16 see some once. 17 Q Okay. Have you ever done any testing 18 of finished talcum powder? 19 A No. 20 MS. O'DELL: 21 Jack, are you at a stopping point? 22 MR. FROST: 23 Yeah. I've got like one more question, 24 and then I'll be done with this topic.</p>	<p style="text-align: right;">Page 89</p> <p>1 Opinions," you've set forth seven opinions. Does 2 that sound right? 3 A Yes. 4 Q Will you agree with me that, you know, 5 these are the opinions -- these are the ultimate 6 conclusions and the opinions that are supported 7 by your report? 8 A Yes. 9 Q And I won't read them all, but I'll 10 start by going over a couple of them. The first 11 opinion states, "Talc deposits derived by the 12 alteration of serpentinites contain chrysotile 13 and amphibole species and fibrous asbestiform 14 habits, all of which are known carcinogens." 15 Did I read that correctly? 16 A I believe so. 17 Q And you'll agree with me that the 18 question here is whether or not -- it's not 19 necessarily what's in the deposit; correct? 20 We're concerned with what's in -- what ends up in 21 the ore. Would you agree with that? 22 MS. O'DELL: 23 Object to the form. 24 A I'm not sure you're not asking a -- a</p>

<p style="text-align: right;">Page 90</p> <p>1 redundant question of some sort, because what is 2 in the ore is in the -- in the -- in the deposit 3 as a whole, unless you want to refine that a 4 little bit. 5 MR. FROST: 6 Q I was gonna say, are you looking at 7 deposit more -- are you looking at deposit as 8 only the ore, or are you looking at deposit as 9 the entirety of -- 10 I'll -- I'll strike that. 11 You agree with me what is the -- the 12 mineable deposit is different than the entirety 13 of the deposit when you're talking about talc; 14 correct? 15 A Yeah. Yes and no. Don't -- I -- I 16 object to the use of the word "deposit." 17 "Deposit," to an economic geologist, means the -- 18 the occurrence of the ore. 19 Q Okay. 20 A And so -- so you're -- what -- I think 21 what you're saying is that the serpentinite as a 22 whole may be mineralogically at variance with the 23 ore deposit itself. 24 Is that what you're asking?</p>	<p style="text-align: right;">Page 92</p> <p>1 MR. FROST: 2 Q Okay. 3 A In -- 4 Q And, so, what I want to get at -- 5 MS. O'DELL: 6 Let him finish. 7 Were you finished, Dr. Cook? 8 A Well, I was gonna -- gonna just finish 9 with one more sentence. 10 MR. FROST: 11 Q Sure. Go ahead. 12 A In -- in the ore deposit itself, the 13 talc ore, of course, is gonna be different from 14 the serpentinite from which it was derived. 15 I mean, serpentinite and talc are not 16 the same thing, so, of course they're different. 17 Q Would you agree with me that, within 18 the talc deposit, you can have areas of the talc 19 that are less pure than other areas of the 20 deposit, say closer to or further from the -- the 21 edges of the deposit? 22 A Sure. 23 Q And you'd agree with me that not the -- 24 not all of that talc will end up getting mined</p>
<p style="text-align: right;">Page 91</p> <p>1 Q That's correct. That's what I'm 2 talking to. 3 You can have -- when you look at a -- I 4 was talking about deposit in more of a global 5 term, that when you have an area of talc, I was 6 looking at that as the deposit and then -- which 7 is separate from the sort of smaller economic 8 deposit of ore that's mineable inside of it. 9 MS. O'DELL: 10 Object to the form. 11 MR. FROST: 12 Q So when you refer to "deposit," you're 13 just talking about the mined ore and not what 14 surrounds it? 15 MS. O'DELL: 16 Object to the form. 17 A It may not be mined. It would be part 18 of the talc deposit per se. These things are 19 part of a -- a larger occurrence of -- of a rock 20 that's silica-deficient, rich in magnesium. It's 21 altered by the influx of warm waters at some 22 point. And within or around or adjacent to maybe 23 in some cases a core of serpentinite, you will 24 have a talc deposit.</p>	<p style="text-align: right;">Page 93</p> <p>1 and used as the ultimate ore; correct? 2 MS. O'DELL: 3 Object to the form. 4 A That may or may not occur. There are 5 companies who will get every single scrap of -- 6 of ore they can, and that would -- that would 7 cause them in some cases to incorporate some of 8 the wall rock in with the last bit of ore that 9 they remove. And, so, that's -- that happens. 10 That's not really very uncommon. 11 MR. FROST: 12 Q Okay. Focusing, though, on cosmetic 13 talc, which, you know, is what we're concerned 14 with here -- 15 A Right. 16 Q -- you'd agree with me that if you have 17 an area of the deposit that is, you know, only 18 5 percent talc and an area of the deposit that is 19 60 percent talc, that the -- what becomes the ore 20 does not necessarily come from the -- they're not 21 gonna use the entire deposit to create cosmetic 22 ore; correct? 23 MS. O'DELL: 24 Object to the form.</p>

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1 A I -- I think that that's -- that's a
 2 fair statement. But you might also say you
 3 wouldn't use the entire deposit to make -325 mesh
 4 talc to put in paint. I mean, it -- you know,
 5 you could say that with respect to a lot of the
 6 products.
 7 MR. FROST:
 8 Q Sure.
 9 So that's what I'm getting at is it's
 10 not necessarily the entire deposit that is of
 11 concern. It's really which part of that deposit
 12 ends up becoming the talc ore. Correct?
 13 A Correct.
 14 MS. O'DELL:
 15 Object to the form.
 16 MR. FROST:
 17 Q Okay.
 18 MS. O'DELL:
 19 Give me just a second.
 20 THE WITNESS:
 21 Yeah. Sorry about that.
 22 MR. FROST:
 23 Q And the first opinion relates to the
 24 alteration of serpentinites. That, for purposes

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1 of this case, only relates to Vermont; right?
 2 A Let me see the way I've worded that
 3 again.
 4 For purposes of this case, yeah.
 5 Q Okay. You'll agree with me that in
 6 China and Italy are derivations of carbonates?
 7 A That's what I'd say, yes.
 8 Q Looking at the second opinion, which is
 9 B, the one that states -- talks about fibrous
 10 talc --
 11 A Right.
 12 Q -- at the very end of that you state
 13 that, "Fibrous talc fulfills the requirements for
 14 inclusion with asbestiform minerals which are
 15 known to be human carcinogens."
 16 A Correct.
 17 Q Okay. And you repeat this on page 9 of
 18 your report.
 19 A Okay.
 20 Q It appears to be -- it's the last
 21 sentence. Is it the last sentence? Sorry. It's
 22 the sentence before that. You talk -- generally,
 23 it's that last paragraph. Again, we're talking
 24 about, you know, fibrous talc, and then, you

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1 know, that it's been determined to have similar
 2 health effects as asbestos, and you quote two
 3 IARC papers.
 4 A Yes.
 5 Q And I think we've -- we've already
 6 determined you're not an expert. You know,
 7 you're not a doctor. You're not a toxicologist.
 8 A No.
 9 Q And are you aware, sitting here today,
 10 of any scientific studies that have determined
 11 fibrous talc to be a human carcinogen?
 12 A I'm aware that IARC says it is.
 13 Q Okay. And, other than IARC, can you
 14 cite to me any other studies that show that
 15 fibrous talc is a human carcinogen?
 16 A I cannot. But I'd like to say that
 17 IARC wouldn't have considered it carcinogenic if
 18 there weren't studies that supported that
 19 conclusion.
 20 Q And you're not here to, you know, opine
 21 what may or may not cause human disease; right?
 22 A No, absolutely not.
 23 Q And do you consider yourself to be an
 24 expert in reading, you know, IARC and

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1 interpreting IARC monographs?
 2 A No.
 3 Q Okay. And you agree with me that the
 4 IARC monographs themselves aren't firsthand
 5 research papers; correct?
 6 MS. O'DELL:
 7 Object to the form.
 8 A I think that there are people that
 9 would consider some of them research papers in
 10 that it is they are drawing conclusions based on
 11 research into the literature with a hypothesis
 12 that fibrous talc does cause cancer or they might
 13 use an alternate hypothesis, fibrous talc does
 14 not cause cancer. And then to support either one
 15 of those opinions, they're looking at the results
 16 of research.
 17 Q You --
 18 A And, so, from that standpoint, maybe
 19 the IARC documents are in a way a research paper.
 20 Q Well, you agree with me they're not
 21 doing any independent lab work?
 22 A I don't think they are.
 23 Q And they're not doing any independent
 24 epidemiology studies on their own?

<p style="text-align: right;">Page 98</p> <p>1 A I don't think so.</p> <p>2 Q Okay.</p> <p>3 A Let me back up. I don't know what</p> <p>4 their budgeting is. There are organizations like</p> <p>5 this that make grants for the study of things</p> <p>6 that they're interested in gathering data on.</p> <p>7 The World Health Organization as a whole I think</p> <p>8 does. National Institute of Health does here in</p> <p>9 the US. They're a very, very robust ranking</p> <p>10 agency.</p> <p>11 Q Okay. With respect to the IARC</p> <p>12 monographs, you'd agree with me that they're</p> <p>13 reviewing work done by other scientists and</p> <p>14 drawing conclusions based on them?</p> <p>15 A That's what I -- sure.</p> <p>16 Q And other than what the conclusions</p> <p>17 that IARC has drawn, you can't point me to any</p> <p>18 peer-reviewed studies that support their</p> <p>19 research?</p> <p>20 A No. I'm -- I'm sure they're listed in</p> <p>21 the monographs.</p> <p>22 Q And you'd also agree with me that IARC</p> <p>23 does not conclude that there's any link between</p> <p>24 fibrous talc and ovarian cancer; correct?</p>	<p style="text-align: right;">Page 100</p> <p>1 A No.</p> <p>2 Q Do you intend to publish your opinions</p> <p>3 in this case?</p> <p>4 A No.</p> <p>5 Q Is there a particular reason why you --</p> <p>6 you do or don't intend to publish them?</p> <p>7 A I don't think it's a -- I don't think</p> <p>8 it's a good practice to do this. I know people</p> <p>9 that do, and they're not looked upon well by</p> <p>10 their peers. I don't think it's good to publish</p> <p>11 data that's generated in litigation.</p> <p>12 Q And it's --</p> <p>13 A That's my personal opinion.</p> <p>14 Q No. That's a fair opinion.</p> <p>15 So you believe there's a difference</p> <p>16 between litigation-derived, you know, research</p> <p>17 and opinions versus academic-derived research --</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 MR. FROST:</p> <p>21 Q -- research and opinions?</p> <p>22 MS. O'DELL:</p> <p>23 I'm sorry.</p> <p>24 MR. FROST:</p>
<p style="text-align: right;">Page 99</p> <p>1 MS. O'DELL:</p> <p>2 Object to the form.</p> <p>3 A I don't know the answer to that.</p> <p>4 MR. FROST:</p> <p>5 Q That's fine. "I don't know" is a</p> <p>6 perfectly acceptable answer.</p> <p>7 A Yeah. I -- I think that they -- that</p> <p>8 ovarian cancer is mentioned. But in the actual</p> <p>9 statement that it's a group 1 member, they</p> <p>10 probably don't mention ovarian cancer per se.</p> <p>11 Q Okay. And --</p> <p>12 A But -- but they might. I don't know</p> <p>13 that.</p> <p>14 Q All right. And you're not an expert on</p> <p>15 the subject, so you can't sit here and tell me</p> <p>16 what types of cancer fibers talc may or may not</p> <p>17 be associated with?</p> <p>18 A No. No.</p> <p>19 Q Other than the seven opinions that we</p> <p>20 have put forth here on pages 2 and 3 of your</p> <p>21 report, do you have any other opinions that you</p> <p>22 plan to render --</p> <p>23 A No.</p> <p>24 Q -- in this case?</p>	<p style="text-align: right;">Page 101</p> <p>1 I didn't -- I didn't think you were</p> <p>2 being rude in talking over me.</p> <p>3 MS. O'DELL:</p> <p>4 Yes. Yeah. I was just trying to get</p> <p>5 my objection in.</p> <p>6 Objection.</p> <p>7 A I'm not saying that there's a</p> <p>8 difference. I think that it has to do with</p> <p>9 motivation behind research, has to do with who's</p> <p>10 paying for it. I think it's more of a</p> <p>11 philosophical issue with me than anything else.</p> <p>12 MR. FROST:</p> <p>13 Q Did you certainly --</p> <p>14 A I've been involved with litigation</p> <p>15 since probably the mid-1970s, and I've never</p> <p>16 thought about publishing the results that I</p> <p>17 obtained during a litigation research project,</p> <p>18 let's say.</p> <p>19 Q Okay. You'd agree with me that's</p> <p>20 because there are issues with potential bias</p> <p>21 issues --</p> <p>22 A Sure.</p> <p>23 Q -- with conflict of interest</p> <p>24 disclosures?</p>

<p style="text-align: right;">Page 102</p> <p>1 MS. O'DELL:</p> <p>2 Excuse me. Give me a chance.</p> <p>3 A Sorry.</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 I don't think there's a question</p> <p>7 pending, Doctor.</p> <p>8 MR. FROST:</p> <p>9 Q Yeah. I was going to say, did you</p> <p>10 answer?</p> <p>11 The second part of the question, so</p> <p>12 you -- the second part of the question is, you</p> <p>13 know, one of the issues would be conflict of</p> <p>14 interest disclosures, sources of funding, things</p> <p>15 like that would all, you know, go into the</p> <p>16 decision as to whether or not, you know, you</p> <p>17 would decide to publish?</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 A The conflict of interest is -- is a</p> <p>21 really important topic. And -- and I agree that</p> <p>22 would be one of the reasons not to.</p> <p>23 MR. FROST:</p> <p>24 Q Okay. Turn to page 4 of your report.</p>	<p style="text-align: right;">Page 104</p> <p>1 So what are the characteristics that</p> <p>2 these minerals have to have to be called</p> <p>3 asbestos? Well, fibrous. They've got to have an</p> <p>4 aspect ratio of -- some people want to say as low</p> <p>5 as 3-to-1. I don't agree with that. 5-to-1 is</p> <p>6 what most people, I think, would use today.</p> <p>7 They occur in groups of parallel</p> <p>8 fibers. Can be -- you can call them bundles.</p> <p>9 Bundles can show -- if you look at the end of a</p> <p>10 bundle, you can see that they -- that there is --</p> <p>11 they are composed of more than one particle. You</p> <p>12 can begin to see a spray at the end of a bundle.</p> <p>13 These things are -- they're flexible.</p> <p>14 In other words, you can bend them without</p> <p>15 breaking, for the most part, although that's a</p> <p>16 little bit questionable because the -- the</p> <p>17 tendency to break perpendicular to the length in</p> <p>18 amphiboles is different from -- in chrysotile.</p> <p>19 So there can be a little bit of a difference</p> <p>20 there.</p> <p>21 The tensile strength is usually pretty</p> <p>22 high.</p> <p>23 Q Okay.</p> <p>24 A Resistance to electricity, resistance</p>
<p style="text-align: right;">Page 103</p> <p>1 At the beginning of the second paragraph you note</p> <p>2 that talc deposits can attain -- can contain</p> <p>3 asbestos.</p> <p>4 A Uh-huh.</p> <p>5 Q How do you define asbestos?</p> <p>6 A Well, fibrous mineral that is -- I'm</p> <p>7 trying to decide how to describe mineralogically</p> <p>8 what they are, because the original six</p> <p>9 chrysotile and then the five amphiboles that are</p> <p>10 mentioned, the five amphiboles, some of them are</p> <p>11 not even minerals anymore. And, so, somebody</p> <p>12 somewhere has got to go in and actually redefine</p> <p>13 asbestos mineralogically.</p> <p>14 For example, anthophyllite is actually</p> <p>15 a solid solution series with anthophyllite at one</p> <p>16 end and ferro-anthophyllite at the other. But</p> <p>17 ferro-anthophyllite is a mineral that forms</p> <p>18 asbestos, and yet it's not mentioned in the</p> <p>19 original definition of asbestos. They just say</p> <p>20 anthophyllite.</p> <p>21 And, so, traditionally you've got --</p> <p>22 you've got chrysotile is your serpentine member</p> <p>23 of the asbestos family, and then you've got the</p> <p>24 five amphiboles. Well, okay. That's great.</p>	<p style="text-align: right;">Page 105</p> <p>1 to heat. I think that they need to be larger</p> <p>2 than 5 microns in length to be of significance.</p> <p>3 So what we're really talking about are</p> <p>4 fibers, minerals that occur in fibers that have</p> <p>5 to belong to generally that group of minerals</p> <p>6 that were originally described.</p> <p>7 Q And do you recall what the five</p> <p>8 amphibole minerals were?</p> <p>9 A Well, the problem with this is that</p> <p>10 some of them are called minerals and they're</p> <p>11 actually trade names.</p> <p>12 Q Okay.</p> <p>13 A Like amosite is not a mineral at all.</p> <p>14 You know, that's gonna be grunerite, for the most</p> <p>15 part.</p> <p>16 Crocidolite is actually a sodium</p> <p>17 amphibole called riebeckite. And so there's</p> <p>18 actinolite, tremolite, then those two and</p> <p>19 anthophyllite.</p> <p>20 Q Okay. And are you familiar with the</p> <p>21 term "asbestiform"?</p> <p>22 A Yes.</p> <p>23 Q And the asbestiform habit?</p> <p>24 A (Nods affirmatively.)</p>

<p style="text-align: right;">Page 106</p> <p>1 Q Could you describe for me or can you 2 define for me what asbestiform means? 3 A We sort of talked about it in the 4 definition of asbestos. But asbestiform, again, 5 is related to a fibrous nature. And, from my 6 perspective, I've looked at a lot of asbestos in 7 rock samples. 8 Now, granted, the -- what you see in a 9 rock sample is gonna be coarse-grained asbestos. 10 And, so, if you see a little band of asbestos, 11 generally the fibers will be perpendicular to the 12 edges of that band, and if it -- if it's 13 asbestos, the chances are you can rub your 14 fingernail across it and actually dislodge -- 15 dislodge fibers. There are minerals that form 16 the same type of a band that you can't. 17 Q Uh-huh. 18 A And they will not dislodge. And 19 usually that won't be -- that won't be asbestos. 20 But the two may look asbestiform. So the real 21 question is can you have an asbestiform mineral 22 that is not asbestos? And the answer is yes. 23 Q Okay. 24 VIDEOGRAPHER:</p>	<p style="text-align: right;">Page 108</p> <p>1 Doctor? 2 THE WITNESS: 3 Yeah, I think so. 4 MR. FROST: 5 Q And with respect to the five 6 amphiboles, you'd agree with me it's the 7 asbestiform or the fibrous variant that's defined 8 as, quote, asbestos, closed quote; correct? 9 MS. O'DELL: 10 Object to the form. 11 A I'm sorry, Jack. Can you ask that -- 12 MR. FROST: 13 Sure. 14 Q And you'd agree with me, with respect 15 to the five amphiboles, it's the fibrous or 16 asbestiform version of those amphiboles that is 17 defined as, quote, asbestos, closed quote? 18 MS. O'DELL: 19 Object to the form. 20 A That is correct. But there is some -- 21 the literature is inconsistent in that regard. 22 There should -- if you've got -- if you've got 23 actinolite asbestos, it should always say 24 actinolite asbestos --</p>
<p style="text-align: right;">Page 107</p> <p>1 Can I go off the record really quickly? 2 MR. FROST: 3 Sure. 4 VIDEOGRAPHER: 5 The time is 10:42 a.m. 6 (OFF THE RECORD.) 7 VIDEOGRAPHER: 8 We're back on the record. The time is 9 10:42 a.m. 10 MR. FROST: 11 Q And, so, we're talking about the 12 definition of asbestos. Chrysotile, I believe, 13 is always asbestiform. That's the asbestiform 14 serpentine? 15 A If you -- if you actually apply a 16 minimum length to the fiber to chrysotile, then 17 it isn't always asbestiform. 18 Q Oh, okay. 19 A I mean, it can be below that 5 micron 20 and then, you know, it's out the door as 21 asbestos. 22 Q And, then, with respect -- 23 MS. O'DELL: 24 Are you finished -- were you finished,</p>	<p style="text-align: right;">Page 109</p> <p>1 MR. FROST: 2 Q Okay. 3 A -- or fibrous actinolite. There 4 should -- there should be a modifier if you're 5 going to -- to go from the mineral species by 6 itself into the realm of asbestos. 7 Q And that's sort of the question I was 8 getting to. There's a difference between -- 9 And we'll use actinolite, which you 10 just used. 11 There's actinolite, which isn't 12 necessarily asbestos, and then there's 13 asbestiform or fibrous actinolite, which is. 14 Correct? 15 A Correct. 16 Q And you can have one without the other; 17 right? 18 A Correct. 19 MS. O'DELL: 20 Object to the form. 21 MR. FROST: 22 Q And do you know what a cleavage 23 fragment is? Is that a term you're familiar 24 with?</p>

<p style="text-align: right;">Page 110</p> <p>1 A Correct. It is.</p> <p>2 Q Okay. Can you please explain to me</p> <p>3 what a cleavage fragment is?</p> <p>4 A A cleavage fragment, according to the</p> <p>5 American Geological Institute, their definition</p> <p>6 is wrong, and I can tell you why. But their</p> <p>7 definition is that it's a crystal particle that</p> <p>8 is bounded by cleavage surfaces. And since not</p> <p>9 all crystals have three directions of cleavage</p> <p>10 that would give you cleavage on every side, that</p> <p>11 can't be right.</p> <p>12 But, in essence, it's a -- a broken</p> <p>13 crystal fragment that is bounded at least</p> <p>14 partially by planes of breakage rather than</p> <p>15 crystallization.</p> <p>16 Q Would you agree with me that the</p> <p>17 difference between a cleavage fragment and an</p> <p>18 asbestiform fiber is the habit in which it grew,</p> <p>19 the way in which it developed?</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 A Let me answer that this way. The</p> <p>23 answer is yes and no. It's possible to have an</p> <p>24 amphibole that is truly an asbestos fiber. And</p>	<p style="text-align: right;">Page 112</p> <p>1 Well...</p> <p>2 Q So how would you go about determining</p> <p>3 whether a population of particles are cleavage</p> <p>4 fragments versus asbestiform fibers?</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A I -- I would hit it with the polarizing</p> <p>8 microscope first so -- because that allows you to</p> <p>9 look at a lot of -- a lot of grains.</p> <p>10 You know, one of the problems with this</p> <p>11 is that as you -- as you look at finer and finer</p> <p>12 grain material, your ability to look at large</p> <p>13 numbers of grains diminishes. I like to pop a</p> <p>14 sample, ground it up not too fine but grind it</p> <p>15 up, put it in an immersion oil and put it under a</p> <p>16 petrographic microscope and see what I see.</p> <p>17 I would also like to have a thin</p> <p>18 section of that same sample, because sometimes in</p> <p>19 a thin section you can see that there is no</p> <p>20 asbestiform thing there at all, and yet you may</p> <p>21 end up with a suspect sample. On the other hand,</p> <p>22 just the opposite can happen.</p> <p>23 So I think that the idea is that you've</p> <p>24 got to start large and -- and work down if</p>
<p style="text-align: right;">Page 111</p> <p>1 because of the cleavage in amphiboles, you can</p> <p>2 take that original asbestos fiber and break it up</p> <p>3 into a cleavage fragment. And, so, therein is</p> <p>4 the problem.</p> <p>5 You can certainly have cleavage</p> <p>6 fragments that were derived from a large single</p> <p>7 crystal that are prismatic, they look like</p> <p>8 needles, and they're not related to an asbestos</p> <p>9 particle. But you can have something that looks</p> <p>10 exactly the same that is. And, so, that's a --</p> <p>11 it's a very tough call.</p> <p>12 MR. FROST:</p> <p>13 Q Are there any properties that you would</p> <p>14 use to identify the difference between a cleavage</p> <p>15 fragment and an asbestiform fiber?</p> <p>16 A With respect to chrysotile, yes, of</p> <p>17 course. With respect to amphiboles, your value</p> <p>18 there is to look at lots and lots of material.</p> <p>19 And if -- if the material is -- is asbestiform,</p> <p>20 you're ultimately gonna see the pieces that are,</p> <p>21 and then you begin to get the -- the concept that</p> <p>22 these cleavage fragments, which are always gonna</p> <p>23 be smaller, are derived from a fiber. I mean, I</p> <p>24 think that you really are --</p>	<p style="text-align: right;">Page 113</p> <p>1 it's -- if it's required.</p> <p>2 MR. FROST:</p> <p>3 Q Okay. Is a good way to summarize that</p> <p>4 that you have to look at the population of</p> <p>5 particles as a whole? You can't just necessarily</p> <p>6 focus in on one or two individual particles to</p> <p>7 make a call?</p> <p>8 MS. O'DELL:</p> <p>9 Objection, to the degree "particles" is</p> <p>10 vague.</p> <p>11 A Yeah. I -- I'm not saying that. I'm</p> <p>12 not saying that if you -- if you look at a small</p> <p>13 population, see a chrysotile particle, that you</p> <p>14 need to then go back and look at a 5-ton rock</p> <p>15 sample just to make sure it was chrysotile. You</p> <p>16 don't have to do that. But if you're worried</p> <p>17 about the presence or absence, period, then you</p> <p>18 need to look at a lot of samples.</p> <p>19 MR. FROST:</p> <p>20 Q Okay. You can't just look at one, you</p> <p>21 know --</p> <p>22 Are you familiar with the term</p> <p>23 "elongated mineral particle"?</p> <p>24 A Sure.</p>

<p style="text-align: right;">Page 114</p> <p>1 Q So you can't just look at one EMP and 2 make a determination as to whether or not that's 3 asbestos? 4 MS. O'DELL: 5 Object to the form. 6 A One particle? You might be able to. 7 Depends on the particle. 8 MR. FROST: 9 Q And what types of things would you have 10 to look for in that particular particle? 11 A Well, are we talking about amphibole or 12 chrysotile? 13 Q I was going to say, I understand 14 amphibole is different because amphibole has a 15 lot of its own characteristics. 16 A All right. 17 Q Let me rephrase my question. We'll -- 18 let's focus on the amphiboles, because I think 19 that's a little more difficult. 20 A Yeah. It is. Yeah, the amphiboles are 21 tough. 22 And your question had to do with an 23 elongated particle, is it asbestiform or not? 24 Q That's correct.</p>	<p style="text-align: right;">Page 116</p> <p>1 it would have a tendency to break. But, still, 2 it's not hard to find amphibole grains that are 3 bent. And when they are, then, you know, then 4 you're beginning to satisfy the definition. 5 Q If I were to show you pictures of, you 6 know, sort of isolated particles under TEM, is 7 that the kind of thing that you could look at and 8 go, yeah, that's cleavage fragment; yeah, that's 9 asbestos? 10 A Sometimes. 11 Q Sometimes? 12 A Sure. Sometimes, yes; sometimes, no. 13 Q Is that something that you routinely do 14 in your job? 15 A No. 16 Q No. 17 Okay. Is it something that you have 18 any experience with doing? 19 MS. O'DELL: 20 Are you talking about TEM? 21 MR. FROST: 22 Q TEM or SEM images. 23 A I mean, I've looked at some. But 24 that's not -- that's not part and parcel of what</p>
<p style="text-align: right;">Page 115</p> <p>1 A The -- I'm not sure that without seeing 2 the sample from which the particle came that you 3 can make a real good call there unless you -- you 4 have an entire particle. Now, some of these 5 particles will not be broken at the ends and you 6 can actually see the termination of the grain. 7 If it is non-asbestiform, the 8 termination will normally be a single oblique 9 plane to the direction of elongation. 10 If it's -- if it's an asbestiform 11 fragment, sometimes these fragments taper to a 12 point. And that's pretty much of a giveaway that 13 you're looking at a single crystallized fiber. 14 Another thing you might do is see 15 whether your population has bent fibers in it. 16 Okay? Many times that's a dead giveaway. 17 Q That has to go with -- I think you -- 18 flexibility or tensile strength are some of the 19 aspects you had listed earlier? 20 A Right. 21 And with amphiboles, you have to be 22 careful because there is a cleavage plane 23 direction that is perpendicular to the 24 elongation. So if you try to bend an amphibole,</p>	<p style="text-align: right;">Page 117</p> <p>1 I normally do. 2 Q Okay. You're not an expert in 3 reviewing TEM or SEM images? 4 A I wouldn't think I was. 5 Q Do you have any opinion as to whether 6 or not surface chemistries of asbestiform or 7 non- -- and non-asbestiform particles are 8 different? 9 A Surface chemistry? 10 Q Yes. 11 A I'm not sure I understand how the 12 surface chemistry's gonna be greatly different 13 from the chemistry through the grain. 14 Q Okay. So that's -- that's not 15 something you have an opinion about, about 16 surface chemistry? 17 A I think that -- I'm not sure -- I'm not 18 sure what you're really asking. 19 The -- if you're gonna do, like, EDAX, 20 how far into the grain do you think you're really 21 analyzing? Is that what you're talking about 22 when you say "surface"? Because you may not be 23 getting an analysis that's gonna be 24 representative of the grain as a whole on --</p>

<p style="text-align: right;">Page 118</p> <p>1 on -- on a lot of these techniques. You're --</p> <p>2 you're -- the penetrating power may not be that</p> <p>3 great.</p> <p>4 But I don't think that -- I don't think</p> <p>5 that I would be greatly concerned about surface</p> <p>6 chemistry versus chemistry five -- five or six</p> <p>7 microns into a grain. I'm not sure there should</p> <p>8 be any big difference unless you're -- there's a</p> <p>9 coating of some sort that -- that maybe is,</p> <p>10 you know, has been applied.</p> <p>11 You know, you have to -- to coat some</p> <p>12 of these samples, anyway, if you're -- if you're</p> <p>13 doing SEM work.</p> <p>14 So, I mean, you know, you get carbon.</p> <p>15 In fact, I'm sure that you've looked at a lot of</p> <p>16 these analyses. And if you look at the analyses,</p> <p>17 you'll see that they'll have silica. They'll</p> <p>18 mark it, and they'll mark it SI. And they'll</p> <p>19 have magnesium, and they'll mark it MG. And then</p> <p>20 about here, there'll be iron. And then just</p> <p>21 beyond iron, there'll be a strong peak. And they</p> <p>22 never identify it, and yet it's there. It's part</p> <p>23 of their analysis. You know what it is? Copper.</p> <p>24 That's the copper peak from the sample. So they</p>	<p style="text-align: right;">Page 120</p> <p>1 MR. FROST:</p> <p>2 Q So you'd agree with me that if you're</p> <p>3 looking at a small population of fibers or you're</p> <p>4 looking at -- well, not fibers, but if you're</p> <p>5 looking at a small population of particles or</p> <p>6 looking at a single particle, a lot of times the</p> <p>7 call as to whether or not it's cleavage or,</p> <p>8 you know, prismatic versus asbestiform fiber</p> <p>9 is -- is subjective unless you have a larger</p> <p>10 population to review?</p> <p>11 MS. O'DELL:</p> <p>12 Excuse me. Object to the form.</p> <p>13 A It can be. I think that -- that it's</p> <p>14 necessary to begin to go back and look at the</p> <p>15 original definitions and begin to try to apply</p> <p>16 them to that particular grain.</p> <p>17 MR. FROST:</p> <p>18 Q Uh-huh.</p> <p>19 A And -- and sometimes it's possible.</p> <p>20 Sometimes it may not be. And that's why it's</p> <p>21 important to look at many, many, many, many, many</p> <p>22 samples, many grains.</p> <p>23 Q Okay. And I take it you have no</p> <p>24 opinion regarding the potential health risks</p>
<p style="text-align: right;">Page 119</p> <p>1 just ignore that.</p> <p>2 And, so -- so you have to -- you have</p> <p>3 to really take a look at the technique that's</p> <p>4 being used if you want to talk about surface</p> <p>5 chemistry versus total chemistry.</p> <p>6 Q And do you have an opinion as to</p> <p>7 whether or not -- I'll call it the cleavage</p> <p>8 fragments versus asbestiform fibers have</p> <p>9 different surface features and different surface</p> <p>10 identifiable markers?</p> <p>11 MS. O'DELL:</p> <p>12 Object to form.</p> <p>13 A I think that -- that it's possible to</p> <p>14 identify cleavage surfaces under some situations,</p> <p>15 because they don't have to be perfectly planar.</p> <p>16 You can have steps where -- where the cleavage</p> <p>17 fragment is actually peeling away from the</p> <p>18 adjacent fragment that results when the two</p> <p>19 separate.</p> <p>20 The problem with this is that that can</p> <p>21 happen in a fiber. I mean, an amphibole fiber,</p> <p>22 if you can come up with a hammer small enough and</p> <p>23 hit it, it's gonna break into cleavage fragments.</p> <p>24 So...</p>	<p style="text-align: right;">Page 121</p> <p>1 associated with a cleavage fragment versus an</p> <p>2 asbestiform --</p> <p>3 A No.</p> <p>4 Q -- mineral?</p> <p>5 A No.</p> <p>6 Q Turn to page -- still on 4 of your</p> <p>7 report. It's the -- the remainder of that</p> <p>8 sentence, "Talc deposits can contain asbestos,</p> <p>9 asbestiform minerals, or minerals containing</p> <p>10 elevated levels of heavy metals and arsenic,</p> <p>11 making their ores potentially unsafe. The</p> <p>12 distribution of asbestos and/or these undesirable</p> <p>13 elements can be quite irregular within individual</p> <p>14 talc deposits themselves or in the immediately</p> <p>15 adjacent host rocks."</p> <p>16 Did I read that right?</p> <p>17 A Sure.</p> <p>18 Q So you -- you'll agree with me that --</p> <p>19 Should I -- is it right to call the ore</p> <p>20 the economic mineral, you know, in a talc</p> <p>21 deposit?</p> <p>22 MS. O'DELL:</p> <p>23 Object to the form.</p> <p>24 A Let -- let's call it the material that</p>

<p style="text-align: right;">Page 122</p> <p>1 you intend to extract and mill.</p> <p>2 MR. FROST:</p> <p>3 Q Okay. You'd agree with me that the</p> <p>4 shape, size, and distribution of that, you know,</p> <p>5 area of mineral you intend to extract as ore can</p> <p>6 be different and irregular?</p> <p>7 A Very.</p> <p>8 Q And they're different for every</p> <p>9 deposit; right?</p> <p>10 A Very. Yes, sure.</p> <p>11 Q It's not always gonna be the same</p> <p>12 shape. It's not always gonna be the same size.</p> <p>13 A That's why they have mining engineers.</p> <p>14 Q And you'd agree with me that each</p> <p>15 mineral deposit is usually complex?</p> <p>16 A Yes.</p> <p>17 MS. O'DELL:</p> <p>18 Object to the form.</p> <p>19 MR. FROST:</p> <p>20 Q You know, and they have complex and</p> <p>21 different geological histories?</p> <p>22 MS. O'DELL:</p> <p>23 Do you mean that specific mineral</p> <p>24 deposits?</p>	<p style="text-align: right;">Page 124</p> <p>1 Object to the form.</p> <p>2 A I mean, you could have things that you</p> <p>3 mentioned that don't even exist in some areas.</p> <p>4 MR. FROST:</p> <p>5 Q Exactly.</p> <p>6 A So, of course.</p> <p>7 Q Okay. And would you also generally</p> <p>8 agree with me that the -- the areas of talc that</p> <p>9 are mined for use in cosmetic talcum powder,</p> <p>10 you know, are much purer than, you know, sort of</p> <p>11 the average deposit of talc you might find</p> <p>12 somewhere in the world?</p> <p>13 A Are you --</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 A Are you restricting this to the -- to</p> <p>17 the US?</p> <p>18 MR. FROST:</p> <p>19 Q I don't have to. I can ask it --</p> <p>20 Is -- is your answer different if it's</p> <p>21 US versus --</p> <p>22 A It is.</p> <p>23 Q -- somewhere else?</p> <p>24 A Yes.</p>
<p style="text-align: right;">Page 123</p> <p>1 MR. FROST:</p> <p>2 Q Just in -- just in general. Well,</p> <p>3 we'll narrow it down to talc deposits.</p> <p>4 MS. O'DELL:</p> <p>5 With the world of talc or world of</p> <p>6 minerals.</p> <p>7 MR. FROST:</p> <p>8 No. I was going to say...</p> <p>9 Q We'll narrow it down to the world of</p> <p>10 talc deposits.</p> <p>11 You'd agree with me that, you know,</p> <p>12 talc deposits can have complex and different</p> <p>13 geological history?</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 A Sure. If you're looking at talc on a</p> <p>17 worldwide basis, of course.</p> <p>18 MR. FROST:</p> <p>19 Q Yeah. And, you know, you'll have</p> <p>20 folding and faulting and you'll have different</p> <p>21 geological circumstances that, you know, may</p> <p>22 affect a localized area that wouldn't affect</p> <p>23 somewhere else?</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 125</p> <p>1 Q Okay. So restricted it to the US. So</p> <p>2 what's your opinion there?</p> <p>3 A Then with -- with respect to the US,</p> <p>4 yeah, it's a higher quality talc.</p> <p>5 Q Okay. And why is that different when</p> <p>6 you then add in worldwide talc deposits?</p> <p>7 A I think that there are examples of</p> <p>8 impure talcs being used in -- in powders that</p> <p>9 have originated from deposits in other countries</p> <p>10 that, you know, that never make it to the US.</p> <p>11 But you see the product analyzed and, you know,</p> <p>12 my -- oh, my God, it's 99 percent asbestos, and</p> <p>13 it's on, you know, every newspaper in the world,</p> <p>14 but it isn't talc that was mined here and it</p> <p>15 isn't talc that was sold in the US.</p> <p>16 Q Okay. I see. And, then, actually,</p> <p>17 now, I really appreciate the difference.</p> <p>18 So with respect to the deposits that</p> <p>19 were used by Johnson & Johnson, you know, say, to</p> <p>20 source the talc for its talcum powder products,</p> <p>21 you know, you'd agree those come from deposits</p> <p>22 that tend to be higher in purity and, you know,</p> <p>23 more monomineralic than, say, other deposits that</p> <p>24 exist?</p>

<p style="text-align: right;">Page 126</p> <p>1 MS. O'DELL: 2 Object to the form. 3 A Yeah. You can't -- you can't say that, 4 simply because the Vermont talc deposits are not 5 monomineralic. They actually mine ore that's 6 talc plus carbonate. 7 MR. FROST: 8 Q Okay. 9 A They do it on purpose. 10 So that's not monomineralic. 11 Q I see. 12 So I guess a better way to ask it, 13 you know, the -- the talcum powder -- the 14 deposits that were used to source the talcum 15 powder for Johnson & Johnson, they tended to be 16 higher percentages of talc and sort of more pure 17 talc deposits than other talc deposits that exist 18 throughout the United States, for example? 19 MS. O'DELL: 20 Object to the form. 21 A No, that's not right. 22 MR. FROST: 23 Q Okay. So you don't believe that, 24 you know, companies try to find talc deposits</p>	<p style="text-align: right;">Page 128</p> <p>1 accessory minerals in every deposit. Is that a 2 fair statement? 3 MS. O'DELL: 4 Are you talking about the same 5 geographic area or different geographic area for 6 the deposit? 7 MR. FROST: 8 Q Just in -- in general, you know, for 9 talc deposits. You know, we can limit it, let's 10 say, for example, in the United States, along the 11 ultramafic belt. 12 MS. O'DELL: 13 Object to the form. 14 A In the ultramafic belt, you can expect 15 to find certain minerals just by virtue of -- of 16 how the ultramafic bodies themselves got to where 17 they are, how they were altered, what -- what 18 metamorphic grade they occur at. 19 And, interestingly enough, the 20 chemistry of the rocks that surround them 21 apparently have a little bit to do with what -- 22 what you're gonna see. 23 MR. FROST: 24 Q Okay. You'd agree with me, just</p>
<p style="text-align: right;">Page 127</p> <p>1 with a higher concentration of talc to use for 2 cosmetic talcum powder? 3 MS. O'DELL: 4 Object to the form. 5 A Not necessarily. I think that -- that 6 with respect to the Vermont talc deposits, 7 probably the best talc in them is the talc that 8 is associated with magnesite. And, so -- 9 And, in fact, that's why the West 10 Windsor mill was so important. It -- that mill 11 was built to handle talc magnesite ore. Because 12 once you get the magnesite out, then you have a 13 relatively nice talc product. But it doesn't 14 start out being pure talc. 15 MR. FROST: 16 Q Okay. Would you also agree with me 17 that when you're looking at sort of talc deposits 18 in general, just because you find some -- 19 Are you familiar with the term 20 "accessory minerals"? 21 A Sure. 22 Q Okay. Just because you find some 23 accessory minerals in one deposit doesn't mean 24 you're gonna find the same compilation of</p>	<p style="text-align: right;">Page 129</p> <p>1 because you find actinolite in one deposit 2 doesn't mean actinolite is gonna be in every 3 single talc deposit along the belt; correct? 4 A My guess is that, if you want to use 5 actinolite as an example, you can pick a talc 6 deposit at random, we can go and spend enough 7 time to find an actinolite grain. 8 Q Okay. 9 A I mean, actinolite is so common. I 10 mean, it's -- it's everywhere. 11 Q All right. How about tremolite or 12 anthophyllite? 13 A Well, tremolite -- here's -- here's the 14 thing with tremolite. Tremolite has calcium in 15 it, and talc doesn't. And, so, if -- if there's 16 calcium in the -- the original rock that's being 17 altered, the calcium has got to have somewhere to 18 go. And tremolite is a very easy place to -- to 19 store calcium. And, so, it's not -- it's not 20 unexpected to see tremolite. 21 You certainly see tremolite in the talc 22 deposits that are formed from carbonate rocks 23 because a lot of those carbonates are dolomites 24 plus calcium carbonate-rich limestone. So</p>

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<p>1 they're -- they're interbedded.</p> <p>2 And, so, you -- you do tend to see</p> <p>3 tremolite in those. But you've got to</p> <p>4 accommodate calcium somehow, and that's -- that's</p> <p>5 a common way.</p> <p>6 Q Okay. But, so you'd agree with me,</p> <p>7 then, that not every deposit of talc is gonna</p> <p>8 have tremolite in it, because they're not all</p> <p>9 gonna be comprised of the same underlying</p> <p>10 original materials before metamorphosis; right?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A I'm -- I'm not gonna say that they all</p> <p>14 don't --</p> <p>15 Talc deposits can be -- you know,</p> <p>16 they're pretty large. And if you found a</p> <p>17 little -- you know, these are little, rootless</p> <p>18 ultramafic bodies. Some of them are no bigger</p> <p>19 than this (indicating). And you might find a</p> <p>20 little teeny one like that, and there won't be a</p> <p>21 tremolite grain within 50 feet of it.</p> <p>22 But in terms of an economic talc</p> <p>23 deposit, I would be shocked if you couldn't go</p> <p>24 and station somebody at the mine the day it</p>	<p>1 instance, I think the Johnson mine has had</p> <p>2 cobaltite reported from it, and -- and we don't</p> <p>3 see any evidence of cobaltite at any of the other</p> <p>4 talc deposits.</p> <p>5 And, so, from that standpoint, sure,</p> <p>6 there -- there can be a difference in the suite</p> <p>7 of accessory minerals.</p> <p>8 But if you're gonna talk about the</p> <p>9 common rock-forming minerals, geez, you know,</p> <p>10 those things show up all over the place.</p> <p>11 I mean, if you look at the black wall,</p> <p>12 you know, most of these deposits have got a -- a</p> <p>13 rind around them; and the black wall, by</p> <p>14 definition, has amphiboles in it. And based on</p> <p>15 the chemistry of these things, they're bound to</p> <p>16 be actinolite.</p> <p>17 MR. FROST:</p> <p>18 Q Okay. You'd agree with me that,</p> <p>19 depending at the pressures, temperature, and the</p> <p>20 time in which they form, what you're gonna find</p> <p>21 associated with each, you know, mineable talc</p> <p>22 deposit's gonna be different?</p> <p>23 MS. O'DELL:</p> <p>24 Object to the form. Asked and</p>
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<p>1 opened and -- and have them do nothing but search</p> <p>2 for tremolite every day, and sometime during the</p> <p>3 operation of that mine they're gonna come in with</p> <p>4 a piece of tremolite. I'd be surprised if</p> <p>5 that -- if that wouldn't happen.</p> <p>6 MR. FROST:</p> <p>7 Q So it's your position, sitting here as</p> <p>8 a scientist, that every single talc deposit in,</p> <p>9 say, the ultramafic belt will have the exact same</p> <p>10 compilation of accessory minerals associated --</p> <p>11 A No.</p> <p>12 Q -- with it?</p> <p>13 A No. I'm not saying that.</p> <p>14 MS. O'DELL:</p> <p>15 Excuse me. Object to the form.</p> <p>16 Misstates his testimony.</p> <p>17 MR. FROST:</p> <p>18 Q Okay. So you agree with me that each</p> <p>19 particular deposit will have its own particular</p> <p>20 set of potential accessory minerals; right?</p> <p>21 MS. O'DELL:</p> <p>22 Object to the form.</p> <p>23 A If we're gonna be very broad in our</p> <p>24 definition of "accessory minerals." For</p>	<p>1 answered.</p> <p>2 A Yeah. I -- I -- the way -- the way</p> <p>3 that you stated that, I -- I don't think I would</p> <p>4 exactly agree with you on that.</p> <p>5 MR. FROST:</p> <p>6 Q You wouldn't agree with me that you</p> <p>7 have to look at the individual formation of each</p> <p>8 deposit to determine, you know, what is or is not</p> <p>9 going to be in it?</p> <p>10 A When you say "the formation," you're</p> <p>11 talking about the -- the genesis, not the rock</p> <p>12 formation?</p> <p>13 Q Yes. I'm talking about the genesis,</p> <p>14 the actual, you know --</p> <p>15 A Yeah.</p> <p>16 Q -- time, heat, pressure of</p> <p>17 metamorphism.</p> <p>18 A The conditions of formation certainly</p> <p>19 control the mineralogy of any rock.</p> <p>20 Q Okay. And the conditions of formation,</p> <p>21 you know, can be extremely localized, correct,</p> <p>22 depending on what the -- what the original rock</p> <p>23 was?</p> <p>24 MS. O'DELL:</p>

Page 134	Page 136
<p>1 Object to the form.</p> <p>2 A It certainly can. There seem to be</p> <p>3 some -- some consistent threads that run through</p> <p>4 these. But if you've looked at any of the mine</p> <p>5 maps, you've seen that some of these deposits are</p> <p>6 certainly cut by faults, and -- and some of these</p> <p>7 faults actually control the disposition of some</p> <p>8 of these accessory minerals.</p> <p>9 MR. FROST:</p> <p>10 Q Uh-huh.</p> <p>11 A So if it's not like faulting, then,</p> <p>12 you know, then you might not see a certain</p> <p>13 mineral.</p> <p>14 Some of these also had lamprophyre</p> <p>15 dikes in them. And those dikes, they have their</p> <p>16 own mineral assemblage. But -- but since it's</p> <p>17 almost impossible to mine some of the talc</p> <p>18 without incorporating some of the lamprophyre,</p> <p>19 then -- then you've got to look at the</p> <p>20 lamprophyre.</p> <p>21 Q Okay. You'd agree with me, you know,</p> <p>22 depending on what the surrounding rock was of the</p> <p>23 serpentinite, when it was formed, the temperature</p> <p>24 and pressure at which it was formed, you know,</p>	<p>1 unit. The -- the most recent publications spell</p> <p>2 it out pretty clearly that -- that that is a -- a</p> <p>3 sequence of rocks that contain carbonates, and</p> <p>4 those carbonates are deformed and they're -- they</p> <p>5 have been originally metamorphosed at apparently</p> <p>6 high grade, because they're garnets in the -- in</p> <p>7 the adjacent schists. And garnets are a mineral</p> <p>8 that -- that actually signals the beginning of a</p> <p>9 certain level of regional metamorphism.</p> <p>10 When you hit garnet grade metamorphism,</p> <p>11 you open up -- it's not really a Pandora's box,</p> <p>12 but you have the opportunity for a lot of -- a</p> <p>13 lot of more complicated mineralogy.</p> <p>14 And -- and that was what I meant in</p> <p>15 that statement. If you -- if you go to the</p> <p>16 literature and read about the accessory minerals</p> <p>17 there in the Italian talc deposits, you'll see</p> <p>18 some minerals mentioned that -- that you don't</p> <p>19 see attributed to some of the stuff in Vermont,</p> <p>20 for instance.</p> <p>21 Q Okay. So that's what you're talking --</p> <p>22 that's what you're talking about is because it's</p> <p>23 hosted from a different type of -- of rock?</p> <p>24 A It's a different type -- it's a --</p>
Page 135	Page 137
<p>1 whether or not it went through multiple stages of</p> <p>2 metamorphosis, all of this would, you know,</p> <p>3 change what might be in that particular localized</p> <p>4 deposit?</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A In terms of accessory minerals, it</p> <p>8 might.</p> <p>9 MR. FROST:</p> <p>10 Q Okay. Okay. Page 4, go to section 1,</p> <p>11 "Chronology of Talc Sources." In that first</p> <p>12 paragraph, we're talking about the Italian mine</p> <p>13 in -- in this; correct? The Fontane mine?</p> <p>14 A Sure.</p> <p>15 Q Okay. And down towards the bottom of</p> <p>16 that paragraph you state, "Deposits from this</p> <p>17 region are known to be mineralogically complex,</p> <p>18 particularly with respect to their host</p> <p>19 metamorphics"?</p> <p>20 A Right.</p> <p>21 Q Can you explain to me how the</p> <p>22 particular deposit at the Fontane mine was</p> <p>23 formed?</p> <p>24 A Yeah. That -- that is a carbonate</p>	<p>1 those are different type deposits.</p> <p>2 Q Okay. And you'd agree with me that,</p> <p>3 you know, the literature basically says that the</p> <p>4 mineralogical composition was effectively stable</p> <p>5 through its formation in the Fontane area or the</p> <p>6 Val Chisone area?</p> <p>7 MS. O'DELL:</p> <p>8 Object to the form.</p> <p>9 MR. FROST:</p> <p>10 Q And remained stable throughout</p> <p>11 subsequent metamorphism?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form.</p> <p>14 A I think I know what you're asking.</p> <p>15 Are you asking about the talc remaining</p> <p>16 stable?</p> <p>17 MR. FROST:</p> <p>18 Q That's correct.</p> <p>19 A That's probably right.</p> <p>20 Q Okay. And, at the end of that</p> <p>21 paragraph, you note, "The deposits were often</p> <p>22 small and mined by underground methods."</p> <p>23 A Yes.</p> <p>24 Q What do you mean by "small"?</p>

<p style="text-align: right;">Page 138</p> <p>1 A The -- the -- some of the earlier 2 descriptions of the -- the Val Chisone district's 3 deposits show them to be lens-like within the 4 host carbonate-bearing strata. And, so, if 5 you've -- if you've ever seen a -- a 6 cross-section of the Germanasca Valley, you've 7 got a valley, and there are mines on both sides 8 of it.</p> <p>9 Q Uh-huh.</p> <p>10 A And at the Fontane mine, you've got -- 11 you've got openings on one side and the other, 12 and they are all accumulated into material that's 13 called Fontane mine. And, yet, they're not 14 really a mine that's connected, and yet they're 15 all in the same stratigraphic horizon.</p> <p>16 If you were to go up or down the 17 valley -- let's say up the valley -- you're 18 following the stratigraphy. Okay? The valley 19 has actually cut through the band of rocks that 20 contain the talc. And Fontane is in -- is, 21 you know, in the sides of the valley.</p> <p>22 If you go up the valley, you're still 23 following that same bed of rock, and there are 24 lens-like occurrences of talc that have been</p>	<p style="text-align: right;">Page 140</p> <p>1 Valley.</p> <p>2 A Yes.</p> <p>3 Q Not necessarily the Fontane deposit.</p> <p>4 A Right. Right.</p> <p>5 Q And have you ever read the work by 6 Sandrone and Zuchetti?</p> <p>7 A I don't recognize the names. It 8 doesn't mean I haven't read it.</p> <p>9 Q Okay. And --</p> <p>10 A Can I -- can I continue with my answer 11 to that last question?</p> <p>12 Q Sure.</p> <p>13 A The reason I mentioned the small mines, 14 there -- there is an issue with -- with -- with 15 talc mining as well as gold mining. If you have 16 a mineral deposit that -- that has value on 17 paper, you have got to convert that mineral 18 deposit into somebody giving you a check for the 19 ore or the finished product.</p> <p>20 And, so, what happens if you're in the 21 Germanasca Valley and you've got a very small, 22 very nice grade, very nice talc deposit? You've 23 got to have some way to mill that.</p> <p>24 Well, suppose there's only one mill in</p>
<p style="text-align: right;">Page 139</p> <p>1 mined. And, so, those would be much smaller 2 mines than the Fontane. The Fontane's a big 3 mine.</p> <p>4 Q Okay. That's what I was gonna get at. 5 That statement doesn't necessarily, you know -- 6 you'd agree with me that the deposit at Fontane 7 mine is actually considered to be a fairly large 8 talc deposit?</p> <p>9 A It's big. Vertically, you're looking 10 at multiple levels that -- I can't remember 11 exactly, but you're looking at least -- at least 12 400 feet in terms of vertical extent in that 13 mine. And I take that to mean that there are 14 multiple ore horizons, which would be 15 interesting. I don't think you're gonna find a 16 talc deposit that's 400 feet thick. I mean, I 17 don't think that's happening.</p> <p>18 So my interpretation of the 19 cross-section I've seen is that there are 20 multiple horizons within the rock unit that 21 contains the -- the talc.</p> <p>22 Q Okay. So the statement you have, you 23 know, that the deposits were often small, that's 24 really more a generalization for the Val Chisone</p>	<p style="text-align: right;">Page 141</p> <p>1 the whole region? And, so, what do you do? You 2 take some samples, you go to the guy that owns 3 the mill and you say, "Um, I've got all this 4 really good talc I'd like to -- I've got to do 5 something with it. Will you buy it?" And if 6 they like it, they say, "Sure," and it just goes 7 right in with the product coming labeled Val 8 Chisone.</p> <p>9 Q And --</p> <p>10 A Because it's the only mill in the 11 region. This happens all over the world. People 12 have smaller deposits, and they feed mills that 13 are actually being run to process ore from the 14 district's main mine.</p> <p>15 Q And, sitting here, you have no evidence 16 to show that that actually happened --</p> <p>17 A No.</p> <p>18 Q -- with respect to the Fontane?</p> <p>19 A I'm just pointing out that that is a 20 very common characteristic --</p> <p>21 Q Okay.</p> <p>22 A -- of mining in general.</p> <p>23 Q But, without speculating, you can't 24 tell me that talc ore used for talcum powder</p>

<p style="text-align: right;">Page 142</p> <p>1 sourced by Johnson & Johnson came from anywhere</p> <p>2 other than the Fontane mine; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I'm not sure that -- that all the</p> <p>6 documents actually say that. I think that some</p> <p>7 of them are careful or, let's just say -- I think</p> <p>8 some of them don't actually name the Fontane mine</p> <p>9 by name. They -- they just talk about the</p> <p>10 district or the -- the -- the valley, the Chisone</p> <p>11 Valley. And I think that it's --</p> <p>12 This is sort of an interesting thing,</p> <p>13 because it may be that -- that the ore that's</p> <p>14 processed from the smaller occurrences might be</p> <p>15 very, very, very high grade or it wouldn't have</p> <p>16 been accepted at the mill.</p> <p>17 MR. FROST:</p> <p>18 Q But you have no evidence to show --</p> <p>19 A No.</p> <p>20 Q -- one way or the other?</p> <p>21 A No, other -- other than they talk about</p> <p>22 small mines. And you don't -- you don't have a</p> <p>23 small mine if there's nowhere to process the ore.</p> <p>24 Q Who -- who talks about small mines?</p>	<p style="text-align: right;">Page 144</p> <p>1 A I think that --</p> <p>2 MS. O'DELL:</p> <p>3 Object to the form.</p> <p>4 A Right. I think today it's a family or</p> <p>5 it was a family-operated enterprise.</p> <p>6 MR. FROST:</p> <p>7 Q Uh-huh.</p> <p>8 A And, so, they own the Fontane mine and,</p> <p>9 so, what they sell is gonna be attributed to the</p> <p>10 Fontane mine.</p> <p>11 Q Okay. Turn to page 5. The first full</p> <p>12 sentence on the page starts, "The first</p> <p>13 comprehensive overview of Vermont's talc deposits</p> <p>14 were given by Chidester, Billings, and Cady in</p> <p>15 1951" --</p> <p>16 A Right.</p> <p>17 Q -- "and a review of the ultramafic</p> <p>18 province of Vermont including its</p> <p>19 serpentinite-associated talc and asbestos</p> <p>20 deposits was published in Ratté in 1982."</p> <p>21 Did I read that right?</p> <p>22 A I think you did. I'm not sure I worded</p> <p>23 it right, but --</p> <p>24 Q And then it continues, "The</p>
<p style="text-align: right;">Page 143</p> <p>1 A Well, it's in the literature.</p> <p>2 Q The literature?</p> <p>3 A Yeah.</p> <p>4 Q The literature talks about small mines?</p> <p>5 A Sure.</p> <p>6 Q But not any of the documents from</p> <p>7 Johnson & Johnson or Imerys; correct?</p> <p>8 A I think they may be mentioned in one of</p> <p>9 the published papers. But that's characteristic</p> <p>10 of -- of any district. You're gonna have large</p> <p>11 mines and small mines. I mean, I can't think of</p> <p>12 anywhere where you've just got one huge mine and</p> <p>13 there never was anything else around it.</p> <p>14 Q Okay. You'd agree with me the Fontane</p> <p>15 mine has been mined, I think, for at least a</p> <p>16 hundred years?</p> <p>17 A Yes.</p> <p>18 Q And it might even be longer?</p> <p>19 A Yes.</p> <p>20 Q And that's -- you know, any time that</p> <p>21 evidence actually points to where the</p> <p>22 Italian-sourced talc came from, it specifically</p> <p>23 talks about the company that operates the Fontane</p> <p>24 mine and the Fontane mine; correct?</p>	<p style="text-align: right;">Page 145</p> <p>1 consanguinity of talc and asbestos in such</p> <p>2 deposits is further supported by the numerous</p> <p>3 descriptions of both talc and asbestos in</p> <p>4 deposits such as Bain (1934; 1942). The intimate</p> <p>5 association of amphiboles, including those of</p> <p>6 asbestiform habit with talc deposits derived from</p> <p>7 serpentinites and related rocks, is discussed by</p> <p>8 Van Gosen (2004)."</p> <p>9 Correct?</p> <p>10 A Right.</p> <p>11 Q All right. So the way the last</p> <p>12 sentence reads, you're not saying that every talc</p> <p>13 rock is guaranteed to have asbestos and</p> <p>14 amphiboles associated in it; correct?</p> <p>15 A No, I'm not saying that.</p> <p>16 Q Okay. All right.</p> <p>17 I'm gonna mark --</p> <p>18 What exhibit are we on?</p> <p>19 THE COURT REPORTER:</p> <p>20 Eight.</p> <p>21 (DEPOSITION EXHIBIT NUMBER 8</p> <p>22 WAS MARKED FOR IDENTIFICATION.)</p> <p>23 MR. FROST:</p> <p>24 Q Mark this as Exhibit 8. And I'll --</p>

<p style="text-align: right;">Page 146</p> <p>1 specifically turning your attention to page 33. 2 I believe it's 33, 34. 3 A My page numbers are -- 4 MS. O'DELL: 5 Front and back, I believe. 6 A Yeah. I've got one with -- with one 7 page number on it. 8 Okay. I've got 33. Have you 9 highlighted it in yellow? 10 MR. FROST: 11 Q The copy I had was highlighted. 12 A Okay. 13 Q I didn't highlight it, but -- 14 A Okay. 15 Q -- it's the only copy I had. 16 Is yours not highlighted? 17 MS. O'DELL: 18 No. 19 MR. FROST: 20 On page 33? 21 MS. O'DELL: 22 No. 23 MR. FROST: 24 Huh. All right. Do you want to</p>	<p style="text-align: right;">Page 148</p> <p>1 A Back to back. 2 Q And if you look down at the section 3 called "Talc in Soapstones," you'll note on the 4 second paragraph -- 5 A Right. Right. 6 Q -- it says, "The talc-soapstone 7 mineralization coincide with the described above 8 for asbestos and is included within the 9 ultramafic process." 10 Correct? 11 A Right. 12 Q So he's referencing specifically with 13 the talc-soapstone mineralization that, you know, 14 it relates to the asbestos discussed above. 15 Right? 16 A Right. 17 Q If you turn to the top of page 34, 18 Ratté states that the talc mines of Windsor 19 Minerals, Inc., in Hammondsville and Ludlow, a 20 Vermont Talc Company mine in Andover, and the 21 Vermont Soapstone Company Mine in Chester are 22 included in the southern talc mining district." 23 Correct? 24 A That's what he says, sure.</p>
<p style="text-align: right;">Page 147</p> <p>1 mark -- maybe we'll mark that one, then. It 2 doesn't really -- unless you care. I don't -- I 3 don't care. 4 MS. O'DELL: 5 If it's -- that's fine if you -- if 6 you've marked that one. 7 MR. FROST: 8 Yeah. I was going to say, I mean, it 9 actually speeds things up -- 10 MS. O'DELL: 11 My hope -- 12 MR. FROST: 13 -- if I point him in the right place. 14 MS. O'DELL: 15 Yeah. That's fine. 16 MR. FROST: 17 Q Okay. So you'll agree with me that the 18 top of the -- of the Ratté -- here on page 33, 19 you know, Ratté's talking about the asbestos 20 deposits, and that's what you mentioned in your 21 paper; correct? 22 A Yeah. He does asbestos and talc in 23 this paper. 24 Q Okay.</p>	<p style="text-align: right;">Page 149</p> <p>1 Q And he's distinguishing the 2 talc-soapstone mineralization that he coincides 3 with the asbestos from the southern -- what does 4 he call it? -- talc mining district. Correct? 5 MS. O'DELL: 6 Object to the form. 7 A I'm not sure that that's what he's 8 saying. But I'll accept that. 9 MR. FROST: 10 Q Yeah. Okay. 11 A But -- but, before we go on, I'd like 12 to point out what he says in the second full 13 paragraph on that page. 14 Q Okay. On which page? 15 A 34. 16 Q 34? Okay. 17 A He warns about the -- the -- the 18 consequences of the occurrence of these minerals 19 together. 20 Q Okay. These -- I don't understand 21 where he's warning. He says Vermont leads the 22 nation in talc production. 23 A No. 24 Q Products manufactured from Vermont are</p>

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<p>1 popular --</p> <p>2 A No. It's the paragraph that starts</p> <p>3 "because of the natural mineralogical</p> <p>4 associations."</p> <p>5 Q Okay. So not the second paragraph?</p> <p>6 A Second full paragraph. At least,</p> <p>7 that's what it is on mine.</p> <p>8 No. I'm sorry. Third. Go ahead.</p> <p>9 MS. O'DELL:</p> <p>10 Why don't you read the section you're</p> <p>11 referring to?</p> <p>12 A All right.</p> <p>13 "Because of the natural mineralogical</p> <p>14 associations of serpentine asbestos and talc,</p> <p>15 similar environmental health concerns" --</p> <p>16 Q Uh-huh.</p> <p>17 A Et cetera, et cetera.</p> <p>18 So he's pointing out the fact that</p> <p>19 asbestos and talc occur in similar environments</p> <p>20 and you'd better watch out.</p> <p>21 Q Okay. But you agree with me he's</p> <p>22 specifically coinciding the deposits together,</p> <p>23 when he's talking about the talc-soapstone</p> <p>24 mineralization and the relationship to the</p>	<p>1 deal.</p> <p>2 And probably the largest asbestos mine</p> <p>3 that ever was in Vermont was on a mountain called</p> <p>4 Belvidere Mountain. And there was an early talc</p> <p>5 mine on Belvidere Mountain in the serpentinite.</p> <p>6 But if you -- if you ask somebody about</p> <p>7 Belvidere Mountain, they're gonna say, "Oh, yeah,</p> <p>8 that's a great old big asbestos mine." And, yet,</p> <p>9 there was talc there.</p> <p>10 And I think Ratté, Ratté, I think, was</p> <p>11 a pretty good state geologist, and I think he --</p> <p>12 he was a visionary and was clearly concerned</p> <p>13 about the occurrence of these two minerals</p> <p>14 together. And that was why I point this out.</p> <p>15 Q Okay. But you agree with me, as he's</p> <p>16 talking about --</p> <p>17 A There's definitely a central and a</p> <p>18 southern district also.</p> <p>19 Q Okay. And these are different --</p> <p>20 different districts in the talc --</p> <p>21 I mean, is it fair to say as you're</p> <p>22 moving south along the Appalachians --</p> <p>23 A They're geographically different.</p> <p>24 MS. O'DELL:</p>
Page 151	Page 153
<p>1 asbestos mines, he specifically is excepting out</p> <p>2 of that talc mines of southern Vermont; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I'm not -- I'm not sure that's what</p> <p>6 he's doing.</p> <p>7 MR. FROST:</p> <p>8 Q Well, that's certainly how the document</p> <p>9 reads, isn't it?</p> <p>10 MS. O'DELL:</p> <p>11 Object to the form.</p> <p>12 A If you read it that way, okay. I read</p> <p>13 that last paragraph as being inclusive of the</p> <p>14 ultramafic belt because I think this whole</p> <p>15 section is the Vermont ultramafic belt.</p> <p>16 MR. FROST:</p> <p>17 Q But you agree with me he's breaking it</p> <p>18 into two different districts, the southern talc</p> <p>19 mining district --</p> <p>20 A Yeah. I think you can actually break</p> <p>21 it into three. And the reason he does that is</p> <p>22 that in northern Vermont, you have a district</p> <p>23 that is dominated by asbestos mining and with --</p> <p>24 with some talc mining, but not a -- not a great</p>	<p>1 Excuse me.</p> <p>2 MR. FROST:</p> <p>3 Q Yes. The geo- -- the -- the two or</p> <p>4 three different talc and chrysotile deposits, you</p> <p>5 know, change as you move south; correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 MR. FROST:</p> <p>9 Q They change and they're different?</p> <p>10 MS. O'DELL:</p> <p>11 Object to the form.</p> <p>12 A I'm not --</p> <p>13 MS. O'DELL:</p> <p>14 Would you mind --</p> <p>15 Excuse me.</p> <p>16 Could you -- would you repeat your</p> <p>17 question?</p> <p>18 MR. FROST:</p> <p>19 Sure.</p> <p>20 Q And you'd agree with me, based on what</p> <p>21 Ratté is saying here, you know, if there's a</p> <p>22 difference between, you know, the northern</p> <p>23 belt --</p> <p>24 Actually, I specifically think he talks</p>

<p style="text-align: right;">Page 154</p> <p>1 about the Belvidere, you know, Mountain --</p> <p>2 A Yeah. Sure.</p> <p>3 Q -- versus the southern talc districts;</p> <p>4 right?</p> <p>5 A He does. But -- but he doesn't say</p> <p>6 that the geology is different.</p> <p>7 Q Well, he defines them as separate</p> <p>8 geological districts, doesn't he?</p> <p>9 A He does. But, I mean, you can go to</p> <p>10 the state of Nevada, and there's 150 different</p> <p>11 gold districts, but they're the same in terms of</p> <p>12 geology. It's a geographic separation of the --</p> <p>13 the -- the -- the areas that tend to have gold</p> <p>14 mineralization.</p> <p>15 Q Okay.</p> <p>16 A But the mineralization is the same.</p> <p>17 Same type.</p> <p>18 Q But you'd agree with me that Ratté is</p> <p>19 very specifically stating that the talc mines of</p> <p>20 southern Wind- -- of Windsor Minerals in the</p> <p>21 southern mining district are different than what</p> <p>22 he talks about with the soapstone mineralization</p> <p>23 district and the asbestos mining district of the</p> <p>24 Upper Missisquoi River Valley.</p>	<p style="text-align: right;">Page 156</p> <p>1 comment and not a peer-reviewed publication;</p> <p>2 right?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I can't say that. It isn't a</p> <p>6 peer-reviewed publication, but you can't say that</p> <p>7 it wasn't peer-reviewed before they were willing</p> <p>8 to publish it. But it isn't a publication. It's</p> <p>9 a response.</p> <p>10 MR. FROST:</p> <p>11 Q Yeah. I was gonna say you'd agree with</p> <p>12 me it's a specific comment or response to</p> <p>13 something --</p> <p>14 A Yes.</p> <p>15 Q -- else that's done; right?</p> <p>16 Now, will you also agree with me</p> <p>17 that -- it's fairly short, but it never</p> <p>18 specifically mentions any of the mines from</p> <p>19 Vermont that were used to source talcum powder</p> <p>20 for Johnson; right?</p> <p>21 A I don't think there's a specific mine</p> <p>22 mentioned in there.</p> <p>23 Q Okay.</p> <p>24 Mark this as Exhibit 10.</p>
<p style="text-align: right;">Page 155</p> <p>1 A Yeah.</p> <p>2 MS. O'DELL:</p> <p>3 Object to the form.</p> <p>4 MR. FROST:</p> <p>5 Q Okay.</p> <p>6 A I would be willing to say that he's</p> <p>7 making a distinction between the two.</p> <p>8 Q Okay.</p> <p>9 (DEPOSITION EXHIBIT NUMBER 9</p> <p>10 WAS MARKED FOR IDENTIFICATION.)</p> <p>11 MR. FROST:</p> <p>12 Q I'll mark as Exhibit 9 --</p> <p>13 A He pronounces his name "rat-TAY."</p> <p>14 Q It's "rat-TAY"?</p> <p>15 A Yeah.</p> <p>16 Q He's French, I guess?</p> <p>17 A Yeah.</p> <p>18 Q Do you recognize this to be --</p> <p>19 Do you have it yet? Here it is.</p> <p>20 A No.</p> <p>21 Q Do you recognize Exhibit 9 to be the</p> <p>22 Bain 1934?</p> <p>23 A Yeah.</p> <p>24 Q Okay. Do you agree that this is a</p>	<p style="text-align: right;">Page 157</p> <p>1 (DEPOSITION EXHIBIT NUMBER 10</p> <p>2 WAS MARKED FOR IDENTIFICATION.)</p> <p>3 MR. FROST:</p> <p>4 Q And, again, do you recognize this to be</p> <p>5 the Bain 1942?</p> <p>6 A Sure.</p> <p>7 Q And, again, you'd agree with me that</p> <p>8 this paper does not address any of the talc mines</p> <p>9 actual utilized by Johnson & Johnson to source</p> <p>10 talc for its talcum powder; correct?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A I don't think it specifically names</p> <p>14 any. I think that the date of the article would</p> <p>15 kind of preclude most of that.</p> <p>16 MR. FROST:</p> <p>17 Q Turn to page 256.</p> <p>18 A Okay.</p> <p>19 Q Second column, the second paragraph</p> <p>20 after the one above Belvidere Mountain Asbestos</p> <p>21 district. Do you see where I am?</p> <p>22 MS. O'DELL:</p> <p>23 So you're on the right-hand side?</p> <p>24 MR. FROST:</p>

<p style="text-align: right;">Page 158</p> <p>1 Yeah, right-hand side.</p> <p>2 A Right-hand side.</p> <p>3 MR. FROST:</p> <p>4 Q It's the last paragraph before</p> <p>5 Belvidere Mountain asbestos district. It's</p> <p>6 the -- if you're going up --</p> <p>7 A Oh, I see it.</p> <p>8 Q -- it's the second paragraph up.</p> <p>9 A Okay. Right.</p> <p>10 Q The second sentence reads, "Every</p> <p>11 ultrabasic intrusive has a talc deposit, and</p> <p>12 about one-third have some fibrous magnesia</p> <p>13 mineral."</p> <p>14 A Okay.</p> <p>15 Q It continues down below, "The</p> <p>16 occurrences illustrate progressively increased</p> <p>17 intensity of change from talc to asbestos in</p> <p>18 proportionate amounts of Belvidere Mountain" --</p> <p>19 That's what we just talked about.</p> <p>20 -- "to completely" --</p> <p>21 How do you pronounce that word?</p> <p>22 MS. O'DELL:</p> <p>23 Did you skip a sentence?</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 160</p> <p>1 Q Yeah.</p> <p>2 Okay. So steatitized bodies at Chester</p> <p>3 in Windham; correct?</p> <p>4 A Correct.</p> <p>5 Q So, effectively, what Bain is saying</p> <p>6 here is that -- you know, he's not saying you</p> <p>7 find fibrous magnesium minerals in every talc</p> <p>8 deposit in Vermont; right?</p> <p>9 A That's right.</p> <p>10 Q And --</p> <p>11 A I'm not sure to what degree he's</p> <p>12 talking about that. Is he -- if he's talking --</p> <p>13 See, this is an Economic Geology</p> <p>14 publication.</p> <p>15 Q Okay.</p> <p>16 A It's on, you know, structural</p> <p>17 relationship of ore bodies. And he may be</p> <p>18 referring to economic asbestos since that's what</p> <p>19 this whole publication is about. I don't see how</p> <p>20 he could say that there is not a single grain of</p> <p>21 asbestos in -- in a -- in talc deposits once you</p> <p>22 get 15 miles south of Belvidere Mountain, let's</p> <p>23 say.</p> <p>24 Q Okay.</p>
<p style="text-align: right;">Page 159</p> <p>1 I did. I skipped one. Because I -- we</p> <p>2 can -- I can read it if you want, but --</p> <p>3 MS. O'DELL:</p> <p>4 I just wanted to make sure we --</p> <p>5 MR. FROST:</p> <p>6 No, no. We're reading it right.</p> <p>7 MS. O'DELL:</p> <p>8 -- we're all staying together.</p> <p>9 MR. FROST:</p> <p>10 Yeah.</p> <p>11 A I'm not sure which one you're talking</p> <p>12 about.</p> <p>13 MR. FROST:</p> <p>14 Q Straight as a S-T-E-A-T-I-T-I-Z-E-D.</p> <p>15 A I can't see it. It's so fine.</p> <p>16 Q I looked it up. I know it means talc,</p> <p>17 but I think it's just an older word.</p> <p>18 A Yeah.</p> <p>19 Q "State-a-zide." Stat- -- statized</p> <p>20 [sic] bodies?</p> <p>21 A Oh. You're talking about steatitized.</p> <p>22 Q Steatitized. There you go. Okay.</p> <p>23 A Yeah. That's just the conversion of</p> <p>24 something to talc.</p>	<p style="text-align: right;">Page 161</p> <p>1 A That doesn't really make good sense.</p> <p>2 Q You agree with me that I read it</p> <p>3 correctly.</p> <p>4 A You --</p> <p>5 Q What he's saying --</p> <p>6 A Yeah. Yeah. You read it --</p> <p>7 Q -- is that you'll get fibrous magnesium</p> <p>8 in about one-third of the talc deposits; correct?</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 MR. FROST:</p> <p>12 Q That's what Bain says.</p> <p>13 A Correct.</p> <p>14 Q And then he also talks about the</p> <p>15 fact --</p> <p>16 A Let me -- let me back up.</p> <p>17 If he just says fibrous magnes- --</p> <p>18 magnesium?</p> <p>19 Q Yeah. Magnesian mineral.</p> <p>20 A Okay. How about those that aren't</p> <p>21 magnesian only? Suppose -- they're calcium</p> <p>22 magnesian or --</p> <p>23 Q Sir, we're just reading what Bain is</p> <p>24 saying.</p>

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<p>1 A I know. But that would -- what he's</p> <p>2 saying specifically would be minerals that were</p> <p>3 magnesian, period.</p> <p>4 Q Okay.</p> <p>5 A That would be chrysotile. And that may</p> <p>6 be -- that may be what he's saying. He may be</p> <p>7 referring to chrysotile and not the amphiboles.</p> <p>8 Q But, again, I'm reading what Bain is</p> <p>9 saying correctly?</p> <p>10 A Correct.</p> <p>11 Q Okay. And then he also talks about</p> <p>12 that there's a difference in the occurrence of --</p> <p>13 he specifically says talc and asbestos in</p> <p>14 proportionate amounts of Belvidere Mountain,</p> <p>15 which we know is the chrysotile mine, and then he</p> <p>16 talks about two completely sterilized [sic]</p> <p>17 bodies" --</p> <p>18 A Right.</p> <p>19 Q I'm sure I pronounced that incorrectly.</p> <p>20 -- "at Chester and Windham."</p> <p>21 Correct?</p> <p>22 So what he's saying is there's a</p> <p>23 difference between the deposit at Belvidere and</p> <p>24 the deposits found south, which are completely --</p>	<p>1 (DEPOSITION EXHIBIT NUMBER 11</p> <p>2 WAS MARKED FOR IDENTIFICATION.)</p> <p>3 MR. FROST:</p> <p>4 Q You recognize this article?</p> <p>5 A Yes.</p> <p>6 Q And, again, you'd agree with me that</p> <p>7 Van Gosen never talks specifically about any of</p> <p>8 the talc mines that have been utilized by</p> <p>9 Johnson & Johnson for talcum powder; correct?</p> <p>10 MS. O'DELL:</p> <p>11 Object to the form.</p> <p>12 A I believe that he does not mention</p> <p>13 specific mines.</p> <p>14 MR. FROST:</p> <p>15 Okay. Mark this as Exhibit 12.</p> <p>16 And leave the 2010 IARC.</p> <p>17 To save space and so I could put it all</p> <p>18 in one box, I didn't bring an extra copy.</p> <p>19 MS. O'DELL:</p> <p>20 Yeah, no problem. Just give me a</p> <p>21 minute to get mine.</p> <p>22 MR. FROST:</p> <p>23 Yes.</p> <p>24 MS. O'DELL:</p>
Page 163	Page 165
<p>1 and I think we had defined steatitized as the</p> <p>2 conversion of talc.</p> <p>3 A Well, it was only Windham.</p> <p>4 Q Okay. And the -- and Windham is the</p> <p>5 area we're talking about; correct?</p> <p>6 A Right.</p> <p>7 Q Okay.</p> <p>8 A You know that if you go -- go back and</p> <p>9 read the publications on Belvidere Mountain,</p> <p>10 there were zones of pure talc six feet thick in</p> <p>11 the asbestos mountain. And had they -- had they</p> <p>12 wanted to, they could have probably built a mill</p> <p>13 that would have -- would have recovered the talc.</p> <p>14 Q Okay. But nobody ever --</p> <p>15 Johnson & Johnson never sourced any</p> <p>16 talc from Belvidere; correct?</p> <p>17 A Correct.</p> <p>18 MR. FROST:</p> <p>19 And I'll mark the Van Gosen article.</p> <p>20 What are we on now? Ten?</p> <p>21 THE COURT REPORTER:</p> <p>22 Eleven.</p> <p>23 MR. FROST:</p> <p>24 Eleven.</p>	<p>1 And that's Exhibit 12?</p> <p>2 MR. FROST:</p> <p>3 Yes.</p> <p>4 (DEPOSITION EXHIBIT NUMBER 12</p> <p>5 WAS MARKED FOR IDENTIFICATION.)</p> <p>6 MR. FROST:</p> <p>7 Q I'll direct your attention to page 283,</p> <p>8 sir. I take it you recognize this as the IARC --</p> <p>9 A Right.</p> <p>10 Q -- 2010 document?</p> <p>11 MS. O'DELL:</p> <p>12 I'm sorry. You have 2010 or 2012?</p> <p>13 MR. FROST:</p> <p>14 2010.</p> <p>15 MS. O'DELL:</p> <p>16 Excuse me. Give me just one more</p> <p>17 second.</p> <p>18 A And which page did you say?</p> <p>19 MR. FROST:</p> <p>20 Q 283.</p> <p>21 A 283? Okay.</p> <p>22 MR. FROST:</p> <p>23 You there, Leigh?</p> <p>24 MS. O'DELL:</p>

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<p>1 Yeah.</p> <p>2 MR. FROST:</p> <p>3 You got it? All right.</p> <p>4 Q About halfway down, there's the -- the</p> <p>5 sentence starts "Chlorite in amphiboles."</p> <p>6 A Yes.</p> <p>7 Q And it reads, "Chlorite in amphiboles</p> <p>8 are usually associated with this type of talc</p> <p>9 deposit, although they are commonly separated in</p> <p>10 space from talc ore (Vermont). The amphiboles</p> <p>11 may or may not be asbestiform, depending on the</p> <p>12 local geological history."</p> <p>13 Did I read that right?</p> <p>14 A Correct.</p> <p>15 Q So what they're saying is you have to</p> <p>16 look at the individual deposit; right?</p> <p>17 A Correct.</p> <p>18 Q All right. So I guess the summary of</p> <p>19 all of this is, you know, local geology is</p> <p>20 important. You can look at the belt, but you</p> <p>21 actually have to look at local geology, too;</p> <p>22 right?</p> <p>23 A Absolutely.</p> <p>24 Q Okay. The next paragraph on page 5 of</p>	<p>1 there is one that -- that shows that there was a</p> <p>2 period when they did -- did use cosmetic grade</p> <p>3 talc from the Johnson mine.</p> <p>4 Q You'd agree with me that the Johnson</p> <p>5 mine was an industrial talc mine; correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 Repeat your question, please.</p> <p>9 MR. FROST:</p> <p>10 Q You'd agree with me that the Johnson</p> <p>11 mine was --</p> <p>12 A I think, primarily.</p> <p>13 Q Yeah. And you'd agree with me that</p> <p>14 the -- the talc ore from the Johnson mine was</p> <p>15 actually sent to a different mill?</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form.</p> <p>18 A I'm not sure that that's correct.</p> <p>19 They -- they -- the Johnson mill had a flotation</p> <p>20 circuit in it that might could have been used to</p> <p>21 come up with some cosmetic grade rock or product.</p> <p>22 MR. FROST:</p> <p>23 Q Okay. You can't point me, sitting here</p> <p>24 right now, to a single document --</p>
Page 167	Page 169
<p>1 your report, the second paragraph of that</p> <p>2 page --</p> <p>3 A We're done with IARC?</p> <p>4 Q Yeah, we're done for now. I'd keep</p> <p>5 that close. I think that comes up --</p> <p>6 A Okay.</p> <p>7 Q -- a bunch of times, but...</p> <p>8 A Okay. Which page did you say? Nine?</p> <p>9 Q Page 5.</p> <p>10 A Oh, 5.</p> <p>11 Okeydoke.</p> <p>12 Q In the second paragraph you note at the</p> <p>13 bottom that, "Talc was sourced from the following</p> <p>14 Vermont mines from 1965 to 2003," and the first</p> <p>15 one you include is Johnson.</p> <p>16 A Right.</p> <p>17 Q Is that a mistake, sir, or do you have</p> <p>18 any evidence to show that talc ever was sourced</p> <p>19 by Johnson & Johnson for talcum powder from the</p> <p>20 Johnson mine?</p> <p>21 A I think that there's a document that</p> <p>22 shows that.</p> <p>23 Q Do you know what document that is?</p> <p>24 A I don't have the number in my head, but</p>	<p>1 A No. I think --</p> <p>2 Q -- to base that opinion on?</p> <p>3 A I think that --</p> <p>4 MS. O'DELL:</p> <p>5 I'm sorry.</p> <p>6 A -- Ms. O'Dell may be looking for it.</p> <p>7 But there is -- there is such a document. I</p> <p>8 found it.</p> <p>9 MR. FROST:</p> <p>10 Q What document are you looking at?</p> <p>11 A (Produces document.)</p> <p>12 Q Which one are you referring to it as?</p> <p>13 This one, the J&J Exhibit 4.</p> <p>14 MS. O'DELL:</p> <p>15 That's what I've -- I've seen it</p> <p>16 referred to as is Exhibit 4. I'm sure there are</p> <p>17 other transcripts that have referred to it</p> <p>18 various ways.</p> <p>19 MR. FROST:</p> <p>20 Okay. We'll call it the J&J Exhibit --</p> <p>21 Exhibit J&J-4 for now.</p> <p>22 Q Do you mind if I read this, sir?</p> <p>23 A No. Please.</p> <p>24 Down at the bottom of one of the pages,</p>

<p style="text-align: right;">Page 170</p> <p>1 there's actually the mention of the Johnson mine</p> <p>2 and the fact that there was some cosmetic talc</p> <p>3 production there.</p> <p>4 Q Okay. I see what you're talking about</p> <p>5 here, sir.</p> <p>6 MS. O'DELL:</p> <p>7 I think he may be talking about another</p> <p>8 page, Jack. Take a look at the whole thing.</p> <p>9 MR. FROST:</p> <p>10 We'll mark this as whatever exhibit</p> <p>11 we're on. Thirteen?</p> <p>12 Just put it there. I was gonna say,</p> <p>13 we'll -- we'll add another exhibit number to</p> <p>14 this -- this document when --</p> <p>15 MS. O'DELL:</p> <p>16 Might be worthwhile to put Cook 13 on</p> <p>17 it or something like that.</p> <p>18 MR. FROST:</p> <p>19 That's right. Oh, it says "Cook."</p> <p>20 MS. O'DELL:</p> <p>21 Oh, it does?</p> <p>22 (DEPOSITION EXHIBIT NUMBER 13</p> <p>23 WAS MARKED FOR IDENTIFICATION.)</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 172</p> <p>1 A Right.</p> <p>2 Q -- or the numbers of talc that are</p> <p>3 coming from the Johnson mine.</p> <p>4 A Right.</p> <p>5 Q And it says Grade 500 and Grade 549.</p> <p>6 A Right.</p> <p>7 Q What evidence do you have to show that</p> <p>8 Grade 500 and Grade 549 were actually utilized by</p> <p>9 Johnson & Johnson in its cosmetic talcum powder</p> <p>10 products at issue in this case?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A I'm not saying that.</p> <p>14 MR. FROST:</p> <p>15 Q Okay. And, in fact, in most of the</p> <p>16 documents, and you refer to it in your report as</p> <p>17 Grade 66, is the Vermont ore that was used by</p> <p>18 Johnson & Johnson; correct?</p> <p>19 A I think so.</p> <p>20 Q Further down on page 5 of your</p> <p>21 report -- it's the end of the fourth paragraph --</p> <p>22 A Okay.</p> <p>23 Q -- you state, "There's ample evidence</p> <p>24 that the main and east Argonaut ore bodies are</p>
<p style="text-align: right;">Page 171</p> <p>1 Q Okay. I hand you this document.</p> <p>2 A Okay. Thank you, sir.</p> <p>3 Q And, so, you're relying on, it looks</p> <p>4 like, the second page of it, if you want to open</p> <p>5 the document.</p> <p>6 MS. O'DELL:</p> <p>7 Why -- why don't you take a look,</p> <p>8 Doctor, and --</p> <p>9 MR. FROST:</p> <p>10 Q Yeah. I was gonna say.</p> <p>11 Can you show me where -- what you're</p> <p>12 relying on to say that talc from the Johnson mine</p> <p>13 was utilized by Johnson & Johnson for its final</p> <p>14 talcum powder products?</p> <p>15 A It's at the bottom of page 3.</p> <p>16 Q Let me see that, sir.</p> <p>17 A But I think that there's actually more.</p> <p>18 I think that there's another document that</p> <p>19 actually puts a limit, a time limit on when they</p> <p>20 were securing cosmetic talc there. It's a short</p> <p>21 period.</p> <p>22 Q If I can turn your attention to the</p> <p>23 second page of this document, it notes -- look</p> <p>24 right here -- it notes the grades of talc --</p>	<p style="text-align: right;">Page 173</p> <p>1 segments of the same body" -- sorry - "same ore</p> <p>2 body swarm, making them and talc derived from</p> <p>3 them essentially equivalent."</p> <p>4 A Right.</p> <p>5 Q What do you mean by -- what's the --</p> <p>6 what's the measure of equivalency you're using</p> <p>7 here?</p> <p>8 A The Argonaut ore body is actually a</p> <p>9 zone of talc that wraps around a -- a remaining</p> <p>10 core of serpentinite. And, so, if you're mining</p> <p>11 on one side of the serpentinite, you've got one</p> <p>12 pit, and you're mining the same rock on the other</p> <p>13 side of the serpentinite. And that's -- that's</p> <p>14 all I was saying. You have one big ore body</p> <p>15 there.</p> <p>16 Q Okay. Do you have any -- any</p> <p>17 geological surveys or any, you know, mine</p> <p>18 drilling data you can point me at to show that</p> <p>19 the two bodies were, you know, identical, or</p> <p>20 you're just saying they were part of the same</p> <p>21 generalized formation?</p> <p>22 A Well, you used the word "identical."</p> <p>23 And I -- you know, we try not to use --</p> <p>24 Q I guess I should -</p>

<p style="text-align: right;">Page 174</p> <p>1 A -- that word in geology.</p> <p>2 Q -- use -- use "equivalent"?</p> <p>3 A Yeah.</p> <p>4 Q So is the equivalency purely that they</p> <p>5 form from the same, you know, the general -- the</p> <p>6 same general formation deposit?</p> <p>7 A Right. I mean --</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A Yeah. Your own documents indicate</p> <p>11 this. You know, there's the 2008 report on</p> <p>12 Argonaut that goes through the geology. But</p> <p>13 you've got -- you've got geologic data that goes</p> <p>14 back, I guess, to 1973 or '4 related to Argonaut</p> <p>15 when it was even an underground mine. And it's</p> <p>16 pretty clear that, as mining progressed there,</p> <p>17 that there was one very large ore body there.</p> <p>18 And -- but it has a piece of serpentinite left,</p> <p>19 as a -- as a lot of these things do.</p> <p>20 Because the ore-forming process works</p> <p>21 in toward the -- toward the center of the</p> <p>22 serpentinite, hoping to eat it up entirely.</p> <p>23 You know, ideally, there wouldn't be any</p> <p>24 serpentinite left. That doesn't happen often.</p>	<p style="text-align: right;">Page 176</p> <p>1 sure --</p> <p>2 Would you finish, Doctor, and then you</p> <p>3 can go, Jack? I'm sorry. It just --</p> <p>4 MR. FROST:</p> <p>5 Yeah.</p> <p>6 MS. O'DELL:</p> <p>7 -- seems like he wasn't finished</p> <p>8 trying --</p> <p>9 MR. FROST:</p> <p>10 Oh. I thought he finished.</p> <p>11 MS. O'DELL:</p> <p>12 -- to explain what he was saying.</p> <p>13 A Yeah. Well, yeah, to sum it up, I</p> <p>14 would say that Argonaut is -- is looking at one</p> <p>15 large ore deposit that's being mined in two pits</p> <p>16 that are separated, because part of the</p> <p>17 serpentinite was not altered to talc. And, so,</p> <p>18 it's in place and it kind of protrudes in, and</p> <p>19 you've got the two big pits on either side of it.</p> <p>20 MR. FROST:</p> <p>21 Q And you're not necessarily saying that</p> <p>22 the talc from one pit is, you know, exactly the</p> <p>23 same as the other. They don't have the same --</p> <p>24 they don't necessarily have the same percentage</p>
<p style="text-align: right;">Page 175</p> <p>1 MR. FROST:</p> <p>2 Q Yeah. I -- I think we can both agree</p> <p>3 that --</p> <p>4 A Sure.</p> <p>5 Q -- you tend to have a serpentinite</p> <p>6 core --</p> <p>7 A Sure.</p> <p>8 Q -- in a lot of these deposits.</p> <p>9 A And, so, that's what it looks like when</p> <p>10 you -- when you look at a map of the mine as it</p> <p>11 progressed. As it was developed, they came in</p> <p>12 and began to -- to mine in an open pit more or</p> <p>13 less where the old underground mine was. But</p> <p>14 then if you -- if you keep looking, this open pit</p> <p>15 expands, and you've got a major working on one</p> <p>16 side of the serpentinite and then one on the</p> <p>17 other side.</p> <p>18 Q All right. So that's the essential</p> <p>19 equivalence is that it's --</p> <p>20 A It's all one big deposit.</p> <p>21 Q -- one geological deposit?</p> <p>22 You're not necessarily --</p> <p>23 MS. O'DELL:</p> <p>24 Excuse me. Sorry, y'all. Just make</p>	<p style="text-align: right;">Page 177</p> <p>1 of talc, the same percentage of other minerals,</p> <p>2 you know, chlorite, for example, things like</p> <p>3 that; right?</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 A I think you can go to any of the mines</p> <p>7 and say that.</p> <p>8 MR. FROST:</p> <p>9 Q Yeah.</p> <p>10 A You can go to the north end, it will be</p> <p>11 slightly different than the south end, or maybe</p> <p>12 it won't be, but --</p> <p>13 Q That's -- that's what I'm getting at</p> <p>14 is, you know, even within the mineral deposit,</p> <p>15 you can have changes of talc composition.</p> <p>16 A That is why it is so important to do</p> <p>17 your drilling and to analyze your core, analyze</p> <p>18 your -- your blast hole drills --</p> <p>19 Q Okay.</p> <p>20 A -- and drill cuttings.</p> <p>21 Q I agree.</p> <p>22 A I mean, you really need to be doing</p> <p>23 that.</p> <p>24 Q All right. Next sentence on page 5,</p>

<p style="text-align: right;">Page 178</p> <p>1 you talk about "The Johnson mine as well as the 2 Hammondsville, Hamm, Rainbow, and Argonaut mines 3 exploited talc deposits that are closely 4 associated with serpentinite bodies. Asbestos 5 minerals, including chrysotile, actinolite, 6 tremolite and anthophyllite, occur in 7 talc-bearing serpentinites." 8 And you're saying that, as a 9 generalization, that, you know, serpentinite 10 obviously is a serpentine mineral, but -- 11 So you're not saying -- you're not 12 saying that every deposit that has converted from 13 serpentinite will always have each one of these 14 particular minerals in it; correct? 15 A No, I'm not saying that. 16 Q And I think we just talked about you 17 have to look at the local geology; right? 18 A That's correct. 19 Q Turning to page 6, under "Mining and 20 Talc Composition" -- 21 A Okay. 22 Q -- third paragraph down starts, "On a 23 daily basis." 24 A Okay.</p>	<p style="text-align: right;">Page 180</p> <p>1 A And, so, the -- the loader operator has 2 got to make some -- some very important decisions 3 as -- as he's mining. And -- and in many mines 4 it's up to the geologist or the mine 5 superintendent to make sure the loader operator 6 knows where the ore is. And oftentimes they use 7 spray paint, because the geologist may be -- may 8 be pretty good about knowing where you've got 9 chlorite-rich rock, or maybe he's seen some 10 asbestos. And, so, he'll spray-paint a line and 11 tell the operator, "Do not cross that line." 12 Q And, then, that's what I was gonna say. 13 It's not the miner himself who's determining -- 14 it's not the guy who's the load operator who is 15 saying where to go. There's actually a geologist 16 or a mine planner or a supervisor? 17 A I said there should be. 18 Q Okay. 19 A I didn't say there was. We can always 20 hope that there is. 21 Q So -- 22 A But, in reality, it isn't always the 23 case. 24 Q But, in general mine theory, there</p>
<p style="text-align: right;">Page 179</p> <p>1 Q Okay. "On a daily basis, the boundary 2 between ore and waste is often determined 3 visually by mining equipment operator based on 4 his experience with that particular ore type. It 5 is a common practice for some mines for the 6 geologists to spray paint lines or otherwise mark 7 the boundaries between ore and non-ore. Although 8 the miner" -- I'm sorry -- "although, to the 9 miner, the rock may look the same on either side 10 of that line, these marks guide him through his 11 shift." 12 Did I read that right? 13 A Yes. 14 Q And you'll agree with me there was 15 actually more done than just, you know, 16 visualization of the talc? You had just talked 17 before about drilling and -- 18 A Well, I was really referring to the guy 19 that's actually doing the mining. The -- the 20 mining is done with a loader and a truck. And 21 somehow the guy running the loader has got to 22 know whether this load goes to the mill or goes 23 to the -- the waste dump. 24 Q Yep.</p>	<p style="text-align: right;">Page 181</p> <p>1 should be a geologist, a supervisor, or somebody 2 who comes up with the daily shift plan or the 3 short-term mine plan; correct? 4 A The -- yes, there should be someone 5 that alerts the person doing the mining to what 6 he should be mining and what he should be -- be 7 telling the train operator or whatever, take this 8 load to the dump. 9 Q Yeah. And that geologist would be 10 looking at drill core samples, blast core 11 samples, I'm sure geological models, things like 12 this to determine, you know, where they'll be 13 mining in that particular shift or where the ore 14 will be? Is that -- that fair? 15 MS. O'DELL: 16 Object to the form. 17 A He -- he had better be using all the 18 data that's available to him for that part of the 19 mine. 20 MR. FROST: 21 Q Okay. 22 A And it can be all or part of what you 23 mentioned. 24 Q Yeah. And one of the ways that's --</p>

<p style="text-align: right;">Page 182</p> <p>1 you know, I think nowadays, I believe they use 2 GPSs and things like that, and the buckets tell 3 them exactly where to go; right? 4 MS. O'DELL: 5 Object to the form. 6 A There are places in the world where you 7 can do that. I'm not sure that that's -- that 8 that would be easy to do in a talc open-pit 9 operation. 10 MR. FROST: 11 Q But, you know, that's just one of the 12 ways, you know. Another visual cue is an 13 engineer is, you know, painting lines so that the 14 operator knows generally which direction to go 15 and where to stop loading ore talc; correct? 16 A Correct. And -- and color is -- is 17 used pretty much everywhere for talc. If you -- 18 I mean, obviously, you -- you need high 19 whiteness, high brightness. And talc, once you 20 begin to get chlorite in it or accessory 21 dolomite, you can begin to make your talc gray, 22 and -- and suddenly you're -- you've got a 23 product that, no matter what you do to it in the 24 mill, you're not gonna get your color right.</p>	<p style="text-align: right;">Page 184</p> <p>1 you write, "In short, it is almost impossible to 2 operate a mine in commodities that occur in 3 relatively small, irregular deposits such as 4 high-quality talc without periodically 5 incorporating host rock, low-grade ore, and/or 6 otherwise undesirable ore into the material being 7 removed from the mine and processed." 8 Okay. So my question there is: On 9 what basis are we defining the possibility? Are 10 you talking about on an hourly basis, a shift, a 11 day, a month, over the life of the mine? 12 A Well, you know, I'm tempted to say "All 13 of the above," but that's not really -- that was 14 not really the way I was saying that. 15 That's a statement that says that when 16 you've got an irregular ore body of variable 17 composition, it's not possible to mine one grade 18 of rock exclusively, day in and day out, without 19 having bits and pieces of adjacent wall rock. 20 I mean, in the underground mine, every 21 time they shoot, you've got to go in with a steel 22 bar and tap the roof and listen for loose rocks 23 or you're -- you're fixing to die. 24 And if you're mining over near the edge</p>
<p style="text-align: right;">Page 183</p> <p>1 Q Uh-huh. 2 A And, so, it may be simply a matter of 3 color. And if that's all it is, then a loader 4 operator may -- may very well be able to handle 5 it. 6 Q Okay. 7 A But if it's something else 8 mineralogically, he may be completely clueless 9 and need someone, likely a geologist or the mine 10 superintendent, to tell him what to do. 11 Q Okay. You'd agree with me it's, 12 you know, it's more than just the guy who's doing 13 the -- the loader. There's a whole process in 14 place, typically, at mines to figure out how to 15 follow the ore body and what to mine and what to 16 waste; correct? 17 A There's -- there's -- 18 MS. O'DELL: 19 Object to the form. 20 A Yes. 21 MR. FROST: 22 Q Okay. 23 A There is supposed to be. 24 Q At the bottom of that page, on page 6,</p>	<p style="text-align: right;">Page 185</p> <p>1 of the ore body, that loose rock on the ceiling 2 could be black wall. And -- and you've got to 3 scale it down. That rock is coming down into 4 your ore. And the miner doesn't -- he's not 5 gonna get it out. 6 And, so, the point is that -- that 7 in -- the reality of mining is such that you -- 8 you don't go out with tweezers and pick the best 9 stuff out. You know, mining is a -- is a -- a 10 process where you -- you come out of a hole with 11 hundreds of tons of rock a day. And -- and to 12 think that -- that every pound that makes up that 13 hundreds of tons is gonna be the purest, best, 14 high-grade talc or whatever ore that there is 15 is -- it just doesn't work like that. 16 Q Okay. And, in fact -- 17 Sorry. 18 A Well, and I was -- I was gonna add that 19 most mines have very specific quality control 20 programs that -- that try to make sure that they 21 are getting the best they can get. But I don't 22 know of -- of any mine I've ever been associated 23 with that didn't have occasional issues with -- 24 with wall rock or -- or a big included xenolith</p>

<p style="text-align: right;">Page 186</p> <p>1 that they were unaware of getting blasted in with 2 their product. 3 And in an open pit it's even worse 4 because, you know, you can try as much as you can 5 to -- to stay in ore, but if you've got an 6 irregular surface that marks the boundary between 7 talc and schists, let's say, your -- your drill 8 cuttings may not tell you that unless you really 9 have somebody looking at drill cuttings for your 10 blast holes every single day. 11 Now, in the quarries that I work on, we 12 blast about sometimes once a week, sometimes once 13 every two weeks. We blast 40- or 50,000 tons at 14 a shot, which would be much larger than at the 15 talc mine. 16 But -- but when we blast, we always 17 find material that we weren't anticipating, and 18 we've got to get rid of it. 19 Q Sure. And -- 20 MS. O'DELL: 21 Jack, do you mind if we go off the 22 record just for a second? 23 MR. FROST: 24 Sure.</p>	<p style="text-align: right;">Page 188</p> <p>1 MS. O'DELL: 2 Object to the form. 3 A It depends on how your mill is set up. 4 There are mills that might not -- might not 5 handle the chlorite-rich cinders. Because when 6 you -- when you crush and grind chlorite, it will 7 tend to report with talc in a -- in a flotation 8 plant. 9 Q But, again, my question was more 10 general than that. 11 A Okay. 12 Q It's when done properly, the point of 13 sorting and beneficiation is to remove these 14 excess rocks and things that end up in the ores; 15 correct? 16 MS. O'DELL: 17 Object to the form. 18 MR. FROST: 19 Q That's -- that's why you do sorting and 20 beneficiation? 21 MS. O'DELL: 22 Object to the form. 23 A The sorting, yes. And beneficiation in 24 general, you're -- you're correct. I wouldn't</p>
<p style="text-align: right;">Page 187</p> <p>1 MS. O'DELL: 2 And if you need to ask a couple -- I 3 don't mean to -- 4 MR. FROST: 5 Yeah, I was going to say, do you mind 6 if I ask two questions? 7 MS. O'DELL: 8 Sure. 9 MR. FROST: 10 Then we can go off. 11 Q And, you know, in mining, that's sort 12 of expected, and that's why you have, on the back 13 end, you have sorting, beneficiation processes, 14 things like that; correct? 15 MS. O'DELL: 16 Object to the form. 17 A Correct. 18 MR. FROST: 19 Q And you'd also agree with me that, 20 you know, the point of sorting, beneficiation, 21 et cetera, when done properly, is to remove that 22 wall rock, host rock, things like that, you know, 23 that we talked about that may end up in the ores; 24 correct?</p>	<p style="text-align: right;">Page 189</p> <p>1 have worded it that way, but, yes. I mean, the 2 object of beneficiation is to make what goes in 3 better when it comes out. 4 MR. FROST: 5 Q Okay. 6 A So, from that standpoint, sure. 7 Q We can take a break. 8 VIDEOGRAPHER: 9 Going off the record. The time is 10 11:52 a.m. 11 (OFF THE RECORD.) 12 VIDEOGRAPHER: 13 We're back on the record. The time is 14 12:11 p.m. 15 MR. FROST: 16 Q Doctor, could you turn to page 7 of 17 your report? 18 A Okay. 19 Q And it's the paragraph that starts 20 "Imerys encountered difficulties." 21 A Right. 22 Q Look at the last sentence of that. It 23 says, "The need for careful, selective mining 24 relative to the controlled potential</p>

<p style="text-align: right;">Page 190</p> <p>1 fiber-bearing zones in Vermont was emphasized in 2 a Cyprus interoffice correspondence." 3 I read that right? 4 A Yes. 5 Q And, if you look down, I take it that's 6 the -- that's the quote from the correspondence 7 we're talking about, the Imerys 219720 below 8 that? 9 A Right. 10 Q Tremolite and use deposits as 11 encountered? 12 The second sentence reads, "Cyprus 13 maintains a selective mining program in Vermont 14 that is directed towards exclusion of all these 15 potentially fiber-bearing zones when the ore is 16 sent to the mills, and those suspect tonnages, 17 including the associated talc, are left in the 18 pit walls or sent to waste piles." 19 Right? 20 A I see that. 21 Q So you agree with me that this 22 indicates that Imerys knew that they had to be 23 selective of the mining in the -- 24 MR. FROST:</p>	<p style="text-align: right;">Page 192</p> <p>1 there was a difference between the ore they 2 wanted to send to the mill and the -- the fibrous 3 waste ore; right? 4 MS. O'DELL: 5 Object to the form. 6 A That is correct, obviously. 7 MR. FROST: 8 Q Okay. And that it shows that they had, 9 in fact, you know, put in a selective mining 10 program to make sure that they weren't capturing 11 these fiber zones within the ore sent to the 12 mills; right? 13 MS. O'DELL: 14 Object to the form. 15 A The -- the implementation of the 16 selective mining is -- is -- I think that that 17 was part and parcel of -- of several agreements 18 that actually stated that in order to -- to -- to 19 make these operations worthwhile and profitable, 20 they had to have selective mining. And, so, from 21 that -- from that standpoint, they have to -- 22 they have to do it. They have to -- they had 23 agreed to do it. 24 MR. FROST:</p>
<p style="text-align: right;">Page 191</p> <p>1 Yeah. 2 MS. O'DELL: 3 I'm just putting in front of him the 4 documents. 5 MR. FROST: 6 The documents? That's fine. 7 Q You agree with me with that statement? 8 You know, that shows that Imerys knew that they 9 had to -- they couldn't use all of the ore body; 10 correct? 11 MS. O'DELL: 12 Object to the form. 13 A That's correct. 14 MR. FROST: 15 Q And it also, you know, indicates that 16 they could tell the difference between what was, 17 you know, effectively the ore and the fibrous 18 waste; right? 19 MS. O'DELL: 20 Object to the form. 21 A Would you ask it again? 22 MR. FROST: 23 Q Sure. 24 And it also indicates that they knew</p>	<p style="text-align: right;">Page 193</p> <p>1 Q Okay. And, in fact -- 2 Sorry. 3 A And, so, you know, the point that I 4 would make is that -- that we asked for all the 5 documents that would demonstrate this, and we did 6 not receive them. 7 Q Well -- 8 A And -- and, so, if we -- if we don't 9 have a way to verify the fact that they 10 implemented a selective mining, then -- then 11 we're left with -- with, you know, with a lot of 12 data that -- that suggests that -- that maybe 13 they didn't. Maybe they just saw white rock and 14 went for it. 15 Q Okay. And, again, you're speculating 16 on whether or not they implemented this or not 17 because you haven't seen all of the data; right? 18 MS. O'DELL: 19 Object to the form. 20 A We asked for the data. 21 MR. FROST: 22 Q Okay. And I want to unpack that a bit. 23 By we -- by "We asked for the data," 24 you mean you asked plaintiffs' counsel to give</p>

<p style="text-align: right;">Page 194</p> <p>1 you all the documents?</p> <p>2 A I asked them to ask for them.</p> <p>3 Q Okay. And you have no way to verify</p> <p>4 whether what -- the selective set of documents</p> <p>5 they gave you contains all of the data that might</p> <p>6 relate to selective mining; correct?</p> <p>7 MS. O'DELL:</p> <p>8 Object to the form.</p> <p>9 A I have no way to know. But -- but it</p> <p>10 wouldn't make sense for them not to -- to give me</p> <p>11 everything they've got that I asked for.</p> <p>12 MR. FROST:</p> <p>13 Q Well, except for the fact that they're</p> <p>14 pursuing theories in these cases, so maybe they</p> <p>15 selected the documents that specifically support</p> <p>16 their theories; correct? That's a possibility.</p> <p>17 A Well, I'm not sure that what they sent</p> <p>18 me supports their theories.</p> <p>19 Q Okay. But, again, without speculating,</p> <p>20 you can't tell me one way or the other what the</p> <p>21 full intent was of the selective mining program</p> <p>22 at Imerys; right? You just don't know if there</p> <p>23 was more, if there's less. You know, you can't</p> <p>24 tell because you don't know if you have all the</p>	<p style="text-align: right;">Page 196</p> <p>1 being done and how potentially effective it was</p> <p>2 at all stages of the mine life; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A The data I have supports the opinion</p> <p>6 that I have that -- that there may not have been</p> <p>7 sufficient selective mining to eliminate all of</p> <p>8 the -- the waste that should have been</p> <p>9 eliminated.</p> <p>10 MR. FROST:</p> <p>11 Q Okay. And you'd agree that that</p> <p>12 opinion is solely based on the data you had</p> <p>13 available to you?</p> <p>14 A That's correct.</p> <p>15 Q And, again, I think we've established</p> <p>16 you'd be open to reviewing other data, and if</p> <p>17 it --</p> <p>18 A Absolutely.</p> <p>19 Q -- supported a different opinion, you'd</p> <p>20 be willing to change your opinion based on that</p> <p>21 data?</p> <p>22 MS. O'DELL:</p> <p>23 Object to the form.</p> <p>24 A I'm -- I'm willing to look at -- at any</p>
<p style="text-align: right;">Page 195</p> <p>1 documents. Is that fair?</p> <p>2 MS. O'DELL:</p> <p>3 Object to the form.</p> <p>4 A I don't -- I would think that I don't</p> <p>5 have all the documents. But in -- in a mining</p> <p>6 scenario, it's -- it's common for documents to</p> <p>7 get destroyed once you're past where you are</p> <p>8 mining.</p> <p>9 And, so, it's possible that -- that</p> <p>10 there were documents that don't exist anymore.</p> <p>11 MR. FROST:</p> <p>12 Q Okay.</p> <p>13 A But selective mining is gonna be tough</p> <p>14 in some of these, especially underground. I</p> <p>15 mean, it's pretty clear that it -- that it --</p> <p>16 that they needed to get -- get out of underground</p> <p>17 as quickly as they could at Hammondsville and at</p> <p>18 Johnson.</p> <p>19 Q Okay.</p> <p>20 A That -- that's a difficult thing to do</p> <p>21 selectively.</p> <p>22 Q You'd agree with me, one way or the</p> <p>23 other, you don't have sufficient evidence to make</p> <p>24 concrete opinions about what selective mining was</p>	<p style="text-align: right;">Page 197</p> <p>1 additional data that comes along.</p> <p>2 MR. FROST:</p> <p>3 Q Turn to page 8 of your report, please,</p> <p>4 last paragraph on the page.</p> <p>5 A Okay.</p> <p>6 Q About halfway down, it's a sentence</p> <p>7 that starts, "It is known that Rio Tinto" --</p> <p>8 A Okay.</p> <p>9 Q -- "identified problems with long</p> <p>10 Guangxi talc ores in 1997 which resulted in the</p> <p>11 recommendation that a Luzenac representative be</p> <p>12 present at the mine during the mining and sorting</p> <p>13 process."</p> <p>14 A Correct.</p> <p>15 Q Correct?</p> <p>16 And then you cite Imerys-A15758?</p> <p>17 A Right. Correct.</p> <p>18 MS. O'DELL:</p> <p>19 Are you gonna mark that, Jack?</p> <p>20 I'll take this one.</p> <p>21 What's the number?</p> <p>22 MR. FROST:</p> <p>23 Fourteen?</p> <p>24 THE COURT REPORTER:</p>

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<p>1 Yes.</p> <p>2 MS. O'DELL:</p> <p>3 Thank you.</p> <p>4 (DEPOSITION EXHIBIT NUMBER 14</p> <p>5 WAS MARKED FOR IDENTIFICATION.)</p> <p>6 MR. FROST:</p> <p>7 Q And I'll turn your attention</p> <p>8 specifically under -- under "Introduction."</p> <p>9 A Okay.</p> <p>10 Q Do you agree with me it talks about</p> <p>11 quality control issues with Cimpact 10?</p> <p>12 A Okay.</p> <p>13 Q And you can review the rest of it, but</p> <p>14 will you also agree with me that the Cimpact 10</p> <p>15 ore is different than the Guangxi number 1 and</p> <p>16 the Guangxi number 2 ores?</p> <p>17 A I think it is.</p> <p>18 Q So you agree that the problems</p> <p>19 identified that this document are specifically</p> <p>20 addressing are the Cimpact 10 quality control</p> <p>21 issues; correct?</p> <p>22 A Hang on a sec.</p> <p>23 MS. O'DELL:</p> <p>24 If you need a minute to review the</p>	<p>1 address it, they're talking about the Cimpact 10</p> <p>2 problems that --</p> <p>3 A Yeah.</p> <p>4 Q -- they had at Grand Island.</p> <p>5 MS. O'DELL:</p> <p>6 Excuse me. Object to the form.</p> <p>7 A Yeah.</p> <p>8 But if they weren't having quality</p> <p>9 control problems at both places, why would they</p> <p>10 mention both places? Doesn't make sense.</p> <p>11 MR. FROST:</p> <p>12 Q What do you mean by "both places"?</p> <p>13 A In the summary. They're talking about</p> <p>14 the Cim- --</p> <p>15 Well, they're talking about Guangxi 1,</p> <p>16 and, so, you've got two separate things you're</p> <p>17 talking about, but they're talking about issues</p> <p>18 with both of them.</p> <p>19 Q Where in this document does it point</p> <p>20 out that they have problems with the testing of</p> <p>21 the Guangxi 1 ore?</p> <p>22 A In the -- in the summary of this</p> <p>23 document.</p> <p>24 Q And you're talking about where it talks</p>
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<p>1 document, Doctor, feel free to do that.</p> <p>2 A In the introduction, they are fairly</p> <p>3 clear that they're worried about Guangxi, not</p> <p>4 Cimpact.</p> <p>5 MR. FROST:</p> <p>6 Q But they're talking about the quality</p> <p>7 control problems with Cimpact; correct?</p> <p>8 A Well, it --</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 A Well, it's not just them. It's -- and</p> <p>12 I'm reading up in the summary. It's indicated</p> <p>13 the need for better technical and probably</p> <p>14 mineralogical specifications for the Guangxi</p> <p>15 number 1 crude. So they're including at least</p> <p>16 some Guangxi in this.</p> <p>17 MR. FROST:</p> <p>18 Q Well, they're talking about they want</p> <p>19 to implement a program for both Cimpact and</p> <p>20 Guangxi; correct?</p> <p>21 A Right.</p> <p>22 Q And then when they specifically talk</p> <p>23 about the quality control problems, you'll agree</p> <p>24 with me, down in the introduction, as they</p>	<p>1 about, at the very beginning --</p> <p>2 A Right.</p> <p>3 Q -- where they say "New specifications</p> <p>4 should go into," and they're talking about the</p> <p>5 Guangxi number 1 crew?</p> <p>6 A Why would they need any specifications</p> <p>7 if they weren't having problems?</p> <p>8 Q But, again --</p> <p>9 A That's the way I read it.</p> <p>10 Q I was going to say, but -- that's how</p> <p>11 you're reading it, but you agree with me the</p> <p>12 document itself only talks about problems that</p> <p>13 have come up with the Cimpact 10 crew --</p> <p>14 A Yeah, after the --</p> <p>15 MS. O'DELL:</p> <p>16 Excuse me. Just let him finish and</p> <p>17 then give me a minute. Okay?</p> <p>18 Are you finished with your question?</p> <p>19 MR. FROST:</p> <p>20 Yes.</p> <p>21 MS. O'DELL:</p> <p>22 Object to the form. Misstates the</p> <p>23 document.</p> <p>24 MR. FROST:</p>

<p style="text-align: right;">Page 202</p> <p>1 Q You'd agree with me the only specific, 2 you know -- 3 When they actually talk about the 4 problems that have come up, they're only talking 5 about problems that have been identified in the 6 Cimpact 10 or Cimpact 710 ore; correct? 7 MS. O'DELL: 8 Object to the form. 9 A Well, I -- I don't agree with that at 10 all. If you go to the second page, about midway 11 down, they start again about Guangxi number 1 12 crude. 13 MR. FROST: 14 Q Okay. 15 A And, so, I mean, I'm not sure that -- 16 why we're making -- why we're saying it's only 17 Cimpact, because it's -- they're talking about 18 Guangxi crude here. 19 Q But where are they talking about 20 quality control problems they've identified with 21 Guangxi 1 crude? 22 A I -- I think that's what they're 23 addressing. You know, they're trying to 24 respecify what they need.</p>	<p style="text-align: right;">Page 204</p> <p>1 Object to the form. 2 MR. FROST: 3 Q Okay. And, again, if we look at 4 Grand Island, it talks about June 24 samples of 5 Cimpact 10 lot. 6 That's on the bottom of page 2. 7 MS. O'DELL: 8 Where are you reading? 9 MR. FROST: 10 Q Right? I've read the document 11 correctly? 12 MS. O'DELL: 13 Okay. Were you on page 2, not page 1? 14 MR. FROST: 15 Yes. 16 MS. O'DELL: 17 And, Dr. Cook, were you -- I mean, 18 don't respond that he's read it correctly -- 19 MR. FROST: 20 Yeah. 21 MS. O'DELL: 22 No, I don't mean this pejoratively. 23 MR. FROST: 24 No. I think the witness and I were on</p>
<p style="text-align: right;">Page 203</p> <p>1 Q But you're speculating, based on new 2 specifications, that they have found some 3 undocumented problem with the Guangxi number 1 4 crude despite the fact that they only list issues 5 with the Cimpact 710? 6 A I'm not sure -- 7 MS. O'DELL: 8 Object to the form. 9 A I'm not sure that's right. It looks to 10 me like this document is addressing Guangxi 11 number 1 and the other. 12 MR. FROST: 13 Q As far as the specifications; right? 14 A Well, with the thought in mind that 15 these need to be changed for some reason. 16 Q Okay. And, again, it seems -- it's not 17 "seems." It says -- the document itself says the 18 bases for the wanting to change are, quote, 19 "after several episodes of quality control 20 problems with the Cimpact 10 and product at the 21 Grand Island during the first quarter of 1997." 22 Correct? 23 A Right. 24 MS. O'DELL:</p>	<p style="text-align: right;">Page 205</p> <p>1 the same page. 2 MS. O'DELL: 3 I don't think you were, because he 4 wasn't looking at that. 5 So the -- I don't mean this in a 6 pejorative sense -- 7 MR. FROST: 8 No. 9 MS. O'DELL: 10 -- but -- 11 Let me finish. 12 So if you -- there's a specific 13 question that you asked about page 2, I wanted to 14 make sure that the doctor understood where you 15 were in the document. 16 MR. FROST: 17 Sure. 18 A You know, if you go beyond what you 19 just read, I mean, there's more to this document 20 than just that. 21 If you go to the next page, there they 22 are looking at Guangxi number 1 again -- 23 MR. FROST: 24 Q Uh-huh. And it shows --</p>

<p style="text-align: right;">Page 206</p> <p>1 A -- as if there's some issue there.</p> <p>2 Q Well, that's just showing the testing</p> <p>3 results, as it said. But the only place it ever</p> <p>4 shows quality control problems is on page 1,</p> <p>5 under the introduction; correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A Hang on a second.</p> <p>9 You have to really wonder, because the</p> <p>10 table that they've got here on page 3 shows</p> <p>11 silica out of spec for Guangxi 1.</p> <p>12 So it seems to me that they -- that</p> <p>13 they realized that they may have an issue and</p> <p>14 that this document is simply pointing it out,</p> <p>15 says, "Let's tighten things up."</p> <p>16 MR. FROST:</p> <p>17 Q Again, that's your interpretation of</p> <p>18 this document. It's clearly not what the</p> <p>19 document says; correct?</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form. Misstates the --</p> <p>22 A I'm not -- I'm not sure it doesn't say</p> <p>23 that. I mean, you read this part here correctly,</p> <p>24 but there's more to the document beyond what you</p>	<p style="text-align: right;">Page 208</p> <p>1 Object to -- object to the form.</p> <p>2 A That's not what it says. It says it in</p> <p>3 one sentence, but that one sentence is part of a</p> <p>4 larger document that, past that one sentence, has</p> <p>5 some analytical data for Guangxi 1, and it shows</p> <p>6 something to be out of spec.</p> <p>7 And it -- it's a very simple thing.</p> <p>8 All they're saying is, "We need to tighten up our</p> <p>9 processes of quality control." They don't say</p> <p>10 this is asbestos. They don't say it's heavy</p> <p>11 metals. And what it really amounts to is a</p> <p>12 little bit of chlorite in the talc.</p> <p>13 Q Okay. And you agree with me it's not</p> <p>14 saying quality control. They're talking about</p> <p>15 changing the specifications.</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form.</p> <p>18 A If you don't want that to be quality</p> <p>19 control, okay.</p> <p>20 MR. FROST:</p> <p>21 Q Well, sure. I mean --</p> <p>22 A If that's what you say isn't quality</p> <p>23 control, I'm gonna -- I'll --</p> <p>24 MS. O'DELL:</p>
<p style="text-align: right;">Page 207</p> <p>1 read.</p> <p>2 MR. FROST:</p> <p>3 Q Okay. It shows the testing results.</p> <p>4 Again --</p> <p>5 A Right. And it shows something else --</p> <p>6 Q Let's walk through it. You ready?</p> <p>7 A -- out of spec, I think.</p> <p>8 Q How do you know? Do you --</p> <p>9 A Because they have the range that the</p> <p>10 analyses have to fall within.</p> <p>11 Q Okay. But does it say there are</p> <p>12 quality control issues with respect to --</p> <p>13 A Well, I mean, what else is going on,</p> <p>14 other than quality control?</p> <p>15 Q But, again, that's your interpretation</p> <p>16 of this document. The actual document itself --</p> <p>17 A It's my opinion that this -- that this</p> <p>18 has to do with quality control.</p> <p>19 Q Okay.</p> <p>20 A And they have included both types here.</p> <p>21 Q But, again, the document itself only</p> <p>22 talks about quality control problems with the</p> <p>23 Cimpact 10 product at Grand Island; correct?</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 209</p> <p>1 No, don't --</p> <p>2 THE WITNESS:</p> <p>3 Okay. I don't agree with it.</p> <p>4 MS. O'DELL:</p> <p>5 Yeah. I mean, don't agree because --</p> <p>6 with -- with the definitions of counsel if you</p> <p>7 don't agree with them.</p> <p>8 THE WITNESS:</p> <p>9 Sure.</p> <p>10 I don't agree.</p> <p>11 MR. FROST:</p> <p>12 Q All right. That's fine.</p> <p>13 Move on to page 9.</p> <p>14 A Okay.</p> <p>15 Q Third paragraph down, "A review of</p> <p>16 milling and beneficiation practices employed at</p> <p>17 Imerys's Houston plant indicate that the</p> <p>18 flotation method utilized for decades in Vermont</p> <p>19 was not used but, rather, a series of grinding</p> <p>20 and air classification processes."</p> <p>21 A Yeah.</p> <p>22 Q Okay. You agree with me that flotation</p> <p>23 isn't the only type of beneficiation that can be</p> <p>24 used on an ore; correct?</p>

<p style="text-align: right;">Page 210</p> <p>1 A I agree.</p> <p>2 Q Okay. In fact, there are bunches of</p> <p>3 different types of beneficiation?</p> <p>4 A Correct.</p> <p>5 Q And the documents you cite here</p> <p>6 specifically talk about how Imerys determined</p> <p>7 that flotation beneficiation was necessary for</p> <p>8 the Vermont ores; correct?</p> <p>9 A Yeah. You use the flotation process if</p> <p>10 you -- if you've got a talc carbonate ore.</p> <p>11 You've got to get rid of the carbonate.</p> <p>12 Q Okay.</p> <p>13 A And, so, that's why you float.</p> <p>14 Q So you agree with me the fact that they</p> <p>15 weren't using flotation on the Chinese ore</p> <p>16 doesn't show that there was necessarily a</p> <p>17 breakdown of the process. They were just using a</p> <p>18 different form of beneficiation?</p> <p>19 A Right. Right. There's no carbonate in</p> <p>20 the -- to speak of in the -- in the Chinese ores.</p> <p>21 Q Okay. The next paragraph down, you</p> <p>22 talk about quality control. Do you see where I</p> <p>23 am? "Quality control issues are discussed" --</p> <p>24 A Okay.</p>	<p style="text-align: right;">Page 212</p> <p>1 A Yeah. It has to do with the type of</p> <p>2 mill. I mean, the mill was set up originally for</p> <p>3 baryte, and -- and it uses a -- an interesting</p> <p>4 air separation technique. And -- and I think</p> <p>5 it's probably very effective for talc.</p> <p>6 But there's -- there's nothing in that</p> <p>7 type of a process that would address heavy metals</p> <p>8 at all, unless the heavy metals were restricted</p> <p>9 to some extremely dense accessory mineral. And I</p> <p>10 don't think we've got evidence for that in the</p> <p>11 Chinese talc.</p> <p>12 Q Okay. And what are you relying on to</p> <p>13 say --</p> <p>14 Well, I guess strike that.</p> <p>15 So is this limited, when we're talking</p> <p>16 here, we're limiting it to the heavy metals?</p> <p>17 MS. O'DELL:</p> <p>18 Object to the form.</p> <p>19 A No. I mean, the same is true if there</p> <p>20 was asbestos in any of the crude that came in.</p> <p>21 Probably it would pass on through with the talc.</p> <p>22 There's nothing set up there in Houston that</p> <p>23 would specifically cut the -- any asbestiform</p> <p>24 mineral out.</p>
<p style="text-align: right;">Page 211</p> <p>1 Q -- below in the report?</p> <p>2 A Sure, uh-huh.</p> <p>3 Q Sort of halfway through that sentence</p> <p>4 you said, you know -- it says, "makes it clear</p> <p>5 non-talc material such as asbestos and high</p> <p>6 concentrations of some heavy metals are included</p> <p>7 in the finished products."</p> <p>8 A Sure.</p> <p>9 Q Are you talking about the ore or are</p> <p>10 you talking about finished talcum product, like</p> <p>11 finished talcum powder, in the sentence?</p> <p>12 A No. I'm talking about the finished</p> <p>13 product.</p> <p>14 Q All right.</p> <p>15 A There's nothing in the Houston mill</p> <p>16 that's gonna get out heavy metals. And if there</p> <p>17 happened to be some asbestos, I don't think that</p> <p>18 that plant -- I mean, it's not set up to handle</p> <p>19 that. So...</p> <p>20 Q And the basis of your opinion on that</p> <p>21 is --</p> <p>22 Have you looked at any sampling data?</p> <p>23 Have you looked at any research or literature</p> <p>24 regarding that?</p>	<p style="text-align: right;">Page 213</p> <p>1 MR. FROST:</p> <p>2 Q So you used the word "probably." Do</p> <p>3 you have any scientific study or research to show</p> <p>4 that the various air beneficiation processes used</p> <p>5 at the Houston mill would be completely incapable</p> <p>6 of removing asbestos from the ore?</p> <p>7 A Well, I didn't --</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A Right. I didn't say it was completely</p> <p>11 incapable. What I -- what I said was that I</p> <p>12 don't think there's anything in the -- in the</p> <p>13 system there now that would cut a -- a</p> <p>14 asbestiform mineral out of the -- out of the</p> <p>15 airflow, you know, once the grinding process has</p> <p>16 been done.</p> <p>17 And, you know, I'm sure there's lots</p> <p>18 of, you know, papers on physical metallurgy</p> <p>19 that'll back that up.</p> <p>20 MR. FROST:</p> <p>21 Q Can you cite me any right now that</p> <p>22 would back up the fact that --</p> <p>23 A I -- I had some --</p> <p>24 Q -- this design --</p>

<p style="text-align: right;">Page 214</p> <p>1 A -- when I came in here, and I can't 2 remember them. 3 Q Okay. 4 A No, I can't remember them. 5 Q So, sitting here today, you can't tell 6 me that? 7 A No. 8 Q Okay. Can you agree with me you've 9 never actually yourself tested any -- 10 A No. 11 Q -- Johnson & Johnson talcum powder? 12 MS. O'DELL: 13 Let him finish with the question, sir. 14 THE WITNESS: 15 I'm sorry. 16 A No, I have not. 17 MR. FROST: 18 Q And your role here isn't to testify 19 that any particular level of heavy metals made it 20 into any finished product, like any -- 21 I'll strike -- I'll -- I'll rephrase 22 that question. 23 You're not here to offer an opinion 24 that any particular bottle of Johnson's --</p>	<p style="text-align: right;">Page 216</p> <p>1 MS. O'DELL: 2 Object to the form. 3 A Every spec sheet I've been given is out 4 of -- is out of compliance. 5 MR. FROST: 6 Q See, that's a very different answer, 7 now, isn't it, between every single sample is out 8 of compliance versus every single sample that was 9 given to you by plaintiffs' counsel? Do you 10 agree? 11 MS. O'DELL: 12 Object to the form. 13 A I'm not sure that they aren't the same 14 thing. 15 MR. FROST: 16 Q You have no way to verify, so you 17 believe you've been shown every single sample of 18 Vermont 66 that exists? 19 A I think that -- 20 MS. O'DELL: 21 Excuse me. Object to the form. 22 Just note that's a very different 23 question. 24 MR. FROST:</p>
<p style="text-align: right;">Page 215</p> <p>1 Johnson & Johnson talcum powder had any 2 particular level of heavy metals or asbestos in 3 it; right? 4 MS. O'DELL: 5 Object to the form. 6 A I am. 7 MR. FROST: 8 Q You're here to talk about individual 9 bottles that were used by consumers? 10 A I'm not gonna say an individual bottle, 11 but I will say this. If you take every analysis 12 you've got of 66, every single one is out of spec 13 for heavy metals. 14 And, so, if that's the case, then -- 15 then go pick a bottle off the shelf today and -- 16 oh, well, not today, but go back in time 20 17 years, pick one off the shelf and analyze it, and 18 it's gonna have excessive amounts of nickel, for 19 sure, probably chromium and probably cobalt. 20 Q So it's your test [sic] that every 21 single test of every single sample of Vermont 66 22 that's ever been done was out of spec for heavy 23 metals? 24 A Every --</p>	<p style="text-align: right;">Page 217</p> <p>1 Okay. You can object to the form. 2 MS. O'DELL: 3 I will object to the form, because 4 that's a different -- 5 A We asked for the results. 6 MR. FROST: 7 Q Okay. 8 A And we requested a set of data. And 9 the set of data we were given shows consistent 10 high levels of those three metals. 11 Q Would you be surprised if I told you 12 that there were hundreds and even thousands of 13 additional sample sets that weren't included in 14 the materials that were given to you by 15 plaintiffs' counsel? 16 MS. O'DELL: 17 Object to the form. 18 A Well, I think that I would like to 19 believe that and I think it would be great to see 20 them. 21 MR. FROST: 22 Q Okay. But you certainly don't have 23 them and you haven't been given them. 24 MS. O'DELL:</p>

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<p>1 Object to the form.</p> <p>2 A If there's thousands of --</p> <p>3 MS. O'DELL:</p> <p>4 Excuse me. Excuse me.</p> <p>5 Object to the form. Misstates the</p> <p>6 record.</p> <p>7 A If there are thousands of additional</p> <p>8 ones, then that implies I haven't seen them,</p> <p>9 which is true.</p> <p>10 MR. FROST:</p> <p>11 Q Okay. And would that change your</p> <p>12 opinion? Because this -- this appears to be</p> <p>13 based on the fact that you're saying every single</p> <p>14 test you've seen is out of spec. Would it change</p> <p>15 your opinion if you were to see a significant</p> <p>16 collection of documents that showed a very</p> <p>17 different result?</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 A The -- the data that we've got for the</p> <p>21 annual composite samples, I think we've got</p> <p>22 annual composites for 19 years. And every one of</p> <p>23 them's out of spec.</p> <p>24 So if you -- if -- and, so, if you come</p>	<p>1 for example, and you're basing this off of 19</p> <p>2 test results despite the fact the product has</p> <p>3 been on the market for over a hundred years?</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form. Misstates his</p> <p>6 testimony.</p> <p>7 A Yeah. That -- that -- I don't see how</p> <p>8 that question is relative to -- to anything</p> <p>9 because of the going-back-hundred-year idea. I</p> <p>10 mean, probably it's true if you could go back a</p> <p>11 hundred years. But I know that the data that</p> <p>12 we've got -- I mean, it's more than just the</p> <p>13 19-year collection of annual composites.</p> <p>14 I mean, that's just a subset of a much</p> <p>15 larger data set we've got. I can't tell you how</p> <p>16 many analyses we've got, but it's many hundreds.</p> <p>17 And there isn't a single data set we've got</p> <p>18 that -- that puts nickel, cobalt, or chromium in</p> <p>19 spec. Not a single one.</p> <p>20 MR. FROST:</p> <p>21 Q Okay. And by "in spec," what are you</p> <p>22 referring to?</p> <p>23 A Ten parts per million.</p> <p>24 Q And where are you getting the spec</p>
Page 219	Page 221
<p>1 up with eight more years worth of annual</p> <p>2 composites, I'm gonna bet you that they're gonna</p> <p>3 be out of spec, too. Because these 19 we've got</p> <p>4 are -- are staggered in time.</p> <p>5 MR. FROST:</p> <p>6 Q Okay. But, again, you're looking at 19</p> <p>7 over, I think, a 115-year history of --</p> <p>8 A No. These are the annual --</p> <p>9 Well, no.</p> <p>10 Q -- of the product.</p> <p>11 A That is not correct. No.</p> <p>12 The -- we didn't start getting any</p> <p>13 analytical data for heavy metals before, say,</p> <p>14 1970. And I don't think anybody cared, really,</p> <p>15 prior to that.</p> <p>16 Q Okay. So, again, you're making</p> <p>17 generalizations --</p> <p>18 A No generalization.</p> <p>19 Q -- based on --</p> <p>20 A I'm telling you fact.</p> <p>21 Q Again, you have to go back to my</p> <p>22 original question that was you can sit here and</p> <p>23 tell me that every single bottle, any particular</p> <p>24 bottle is out of spec for heavy metals, you know,</p>	<p>1 from?</p> <p>2 A It's my value.</p> <p>3 Q I mean, what is the spec?</p> <p>4 A That's what was given in testimony --</p> <p>5 in depositions, and it's in lots of documents</p> <p>6 where the heavy metals are being reported as</p> <p>7 10 ppm lead max, and that was an old-time way of</p> <p>8 reporting a group of metals you reported as lead</p> <p>9 because there was a point in time when everybody</p> <p>10 was terrified of lead. They were so worried</p> <p>11 about lead because of their -- their children.</p> <p>12 You know, it impacts the mental ability of</p> <p>13 children.</p> <p>14 Q Okay. Can you -- you have no opinion</p> <p>15 as to what level of cobalt is required to cause</p> <p>16 human disease, do you?</p> <p>17 A I think cobalt is -- is a Group 2</p> <p>18 element --</p> <p>19 Q Listen to my question, though, sir.</p> <p>20 Do you have an opinion as to what level</p> <p>21 --</p> <p>22 MS. O'DELL:</p> <p>23 He was -- he was answering -- excuse</p> <p>24 me, Jack. He was answering your question.</p>

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1 You may answer.

2 A Yeah. I was gonna -- I was gonna say

3 that if you're thinking of cancer, there may be

4 one level, but if you go -- if you go and try to

5 pull the acceptable levels from -- from various

6 governmental agencies, you find some really

7 strange things because it depends on the medium

8 that you're working with.

9 Like if you were running a landfill,

10 then the --

11 MR. FROST:

12 Q I'll stop you here because I'm just

13 very confused by this. You're not a

14 toxicologist; right?

15 A Right.

16 Q And you're not here to offer any

17 opinions as to whether or not --

18 A I'm trying to answer your question.

19 Q Well, no. That's why -- I was trying

20 to get at that, and that's --

21 You know, my question really is you're

22 not here to offer any opinions that say a

23 particular level of cobalt or a particular level

24 of nickel found in a product can cause human

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1 disease; right?

2 MS. O'DELL:

3 Object to the form. And I would just

4 ask if you'd let the witness finish before you

5 interrupt him, please.

6 If your answer --

7 A Nickel and chromium and arsenic, I

8 think that there's plenty of evidence that the

9 limits are way lower than what --

10 Well, maybe not arsenic. But -- but I

11 think with respect to cancer, nickel and chromium

12 are pretty well established.

13 But -- but the point is that

14 Johnson & Johnson established its own limits.

15 MR. FROST:

16 Q Sir, can you please listen --

17 MS. O'DELL:

18 Let's --

19 MR. FROST:

20 No, no.

21 MS. O'DELL:

22 Excuse me.

23 MR. FROST:

24 He's not answering my question.

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1 MS. O'DELL:

2 He's --

3 MR. FROST:

4 We're on my time.

5 MS. O'DELL:

6 No. He's not --

7 MR. FROST:

8 No. My question is whether or not he

9 believes he's an expert --

10 MS. O'DELL:

11 You cannot interrupt him.

12 MR. FROST:

13 Leigh, my question is whether or not --

14 MS. O'DELL:

15 He's trying to answer the question.

16 MR. FROST:

17 -- he believes he's an expert.

18 It's a "yes" or "no" question.

19 A I've answered that over and over. I

20 said no.

21 MR. FROST:

22 Q That's what I'm saying.

23 A Yes, I have. And I said "no."

24 Q I know. And that's what I'm getting

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1 at. But now you seem to be offering opinions

2 about levels of heavy metals that could be in

3 talcum powder that can cause disease.

4 Are you here to offer an opinion about

5 that today?

6 MS. O'DELL:

7 Excuse me.

8 He's trying to answer your question

9 regarding the specification, so let him answer.

10 THE WITNESS:

11 Yeah.

12 MR. FROST:

13 But, again, that's the question as

14 you're framing it. It's not the actual question

15 I asked.

16 MS. O'DELL:

17 I think he --

18 A Well, I'm gonna answer it. I don't

19 care whether you like it or not.

20 Johnson & Johnson set its specs. The

21 specs have to be there for a reason. And the

22 specs are quite low, and the talcum powder

23 product, it exceeds them. I mean, it's as simple

24 as that. I'm not saying it's causing --

<p style="text-align: right;">Page 226</p> <p>1 I mean, it could be causing gum 2 disease. I don't know. But it's their specs I'm 3 referring to. 4 MR. FROST: 5 Q Okay. And that's my question. 6 A Their own specifications. 7 Q And you can't tell me if out of spec 8 has any -- you know, whether or not any 9 particular level, in spec or out of spec, has any 10 potential concern for causation of human disease; 11 correct? 12 A I am gonna leave that to the experts 13 who I'm sure will have lots to say about that. 14 Q And that's what I was trying to get at, 15 sir. 16 A Okay. 17 Q That's not your area of expertise. 18 A Well, I've answered that question over 19 and over again. I'm not an expert in toxicology. 20 Q Okay. Then next time, don't explain 21 something that you're not into. 22 A Well, you asked the question, and I 23 tried to give you the knowledge that I had. But 24 the basis for my statement is the fact that there</p>	<p style="text-align: right;">Page 228</p> <p>1 MS. O'DELL: 2 Object to the form. 3 A Absolutely. 4 MR. FROST: 5 Q Okay. All right. Turning to the 6 "Mineralogy" section of your report that starts 7 on page 9. 8 A Okay. 9 Q Can you point me to a specific 10 geological report that you rely on that talks 11 about the geological deposit of the Jhizhua talc 12 mine, in the Guangxi province of China? 13 A Yeah. There -- 14 MS. O'DELL: 15 On page 9? 16 MR. FROST: 17 It starts on the -- the section starts 18 on page 9. I'm talking about Section B, 19 "Mineralogy," in general. 20 MS. O'DELL: 21 Okay. And you're directing him to the 22 section on China beginning on page 12? 23 MR. FROST: 24 Yeah. I'm not directing him to any</p>
<p style="text-align: right;">Page 227</p> <p>1 are set specifications that were made by 2 Johnson & Johnson, and the analyses exceed that. 3 I mean, it's just as simple as that. 4 Q Okay. 5 A I'm not trying to say anything more. 6 Q I was gonna say, and that's -- that's 7 what I'm trying to get at. That's all you're 8 saying -- 9 A Yeah. 10 Q -- is that you looked at a set of specs 11 and your opinion is that, based on the testing 12 results you've been given, they're outside of 13 those specs. 14 MS. O'DELL: 15 Object to the form. 16 A It's not an opinion. They are outside 17 of the specs. 18 MR. FROST: 19 Q Well, we call it an opinion -- 20 A It's just a fact. It's a fact. 21 Okay. An opinion. 22 Q But that's -- that's the opinion you're 23 rendering is that, based on the testing results 24 that you reviewed, they were out of spec?</p>	<p style="text-align: right;">Page 229</p> <p>1 specific. It was a general question, and that 2 was, you know, what geological studies do you 3 have that relate to -- 4 A I think the two that I've referenced 5 that are actually published reports. 6 MR. FROST: 7 Q Do you recall which ones those are? 8 A I don't remember the authors. But 9 they're modern reports. And, plus, just recently 10 we got a copy of the geologic map for the mine, 11 which was helpful. 12 Q And for Vermont, do you rely on any 13 very -- you know, any of the specific geological 14 reports that relate to Hammondsville, Hamm, 15 Argonaut, or Rainbow specifically? 16 MS. O'DELL: 17 Object to the form. Vague. 18 A The -- yeah. There are specific 19 reports like there's a U.S. Bureau of Mines 20 report that's -- that's good on the Johnson mine, 21 and there's the Barry Seymour thesis that's 22 pretty good on Johnson. There are two reports on 23 Hammondsville that I looked at. One was by the 24 School of Mines, Colorado School of Mines. One</p>

<p style="text-align: right;">Page 230</p> <p>1 was by Gregg. Then there's a whole series of 2 documentation on -- on Argonaut, many reports on 3 Argonaut that -- 4 MR. FROST: 5 Q Okay. You mentioned the Johnson mine. 6 Again, we established before, but for that one 7 reference that talks about -- 8 I forget the ore numbers. I believe 9 they're 500 -- 507. 10 You have nothing else -- you certainly 11 have nothing to show that Grade 66 talc ever came 12 from the Johnson mine; correct? 13 MS. O'DELL: 14 Object to the form. 15 A I'm not sure about Grade 66. I don't 16 know what they called it when Johnson mine was 17 operating. 18 I think that I have one other document 19 that -- that would indicate that for a short 20 period of time cosmetic talc was produced at 21 Johnson. 22 MR. FROST: 23 Q But you agree with me the only document 24 we've been able to come up with thus far, I</p>	<p style="text-align: right;">Page 232</p> <p>1 misidentification of platy talc lying on plane as 2 potentially fibrous? 3 MS. O'DELL: 4 Object to the form. 5 A I think that that's something that is 6 fairly common. You turn a plate on edge, it 7 looks like fiber. 8 MR. FROST: 9 Q Yeah. And that's because most of the 10 microscopes are 2D as opposed to 3D image? 11 A Correct. 12 MS. O'DELL: 13 Object to the form. 14 A I -- can you -- can you ask or make 15 that statement again about the 2D versus 3D? 16 MR. FROST: 17 Q And that's because when you're looking 18 at a 2D image, it's hard to tell if you're 19 looking at something on plane or on edge? 20 A That's kind of an -- that's an 21 interesting comment, because when you're using a 22 polarized light microscope, if you're just using 23 a ground-up talc sample, the way you do that, you 24 put a little pinch of the talc on a glass slide</p>
<p style="text-align: right;">Page 231</p> <p>1 believe, was Grade 500 and 549, according to my 2 notes -- 3 MS. O'DELL: 4 Objection. 5 MR. FROST: 6 Q -- for the grades that were coming out 7 of the Johnson mine? 8 MS. O'DELL: 9 Object to the form. Misstates -- 10 A That was -- that was what it said at 11 the place that you pointed to. 12 MR. FROST: 13 Q Okay. And you agree that Grade 500 or 14 Grade 49 [sic] would be different than Grade 66, 15 which was also listed -- 16 A I would think so. 17 Q -- on that document? 18 Have you ever done any work identifying 19 talc as either platy or fibrous in your academic 20 career? 21 A I have not. 22 Q Are you aware -- I'll call it the 23 contour, but it's probably the wrong word for it. 24 But are you aware that there's a problem with</p>	<p style="text-align: right;">Page 233</p> <p>1 and then you put a drop of refractive index oil 2 on it. That does tend to make the plates lay 3 down. 4 Q Okay. 5 A And it would reduce the -- probably 6 reduce the number of those standing on edge. 7 And, so, from the standpoint of are you always 8 looking at two-dimensional materials, it's 9 probably not right. 10 If you used a binocular scope, which 11 some people do, for the initial examination, that 12 certainly gives you some depth of field, which 13 then translates into 3D. 14 Q Okay. I guess my comment was sort of a 15 nonscientific way. And that's the images, it's, 16 you know, flat plane versus edge -- 17 A Right. 18 Q -- and the edge can be mistaken for 19 fiber; correct? 20 A Correct. 21 Q Okay. 22 All right. Page 10 of your report 23 under the section of "Italy." 24 A Okay.</p>

<p style="text-align: right;">Page 234</p> <p>1 Q It reads, "Deposits derived from 2 sedimentary carbonate rock, such as the Italian 3 deposits, typically contain accessory minerals 4 that may include asbestos (actinolite and 5 tremolite in asbestiform habits) and the chlorite 6 family minerals." 7 Right? 8 A Correct. 9 Q And then, you know, you continue on to 10 talk about Pooley, and you cite, you know, the 11 various documents. I can read the whole thing if 12 you want. But at the end of that you say various 13 different documents, right, that support that 14 position? 15 A Yeah. 16 Q Okay. 17 I'll mark -- what number are we at? 18 THE COURT REPORTER: 19 15. 20 MR. FROST: 21 I should be able to get through this 22 pretty quickly, Leigh, and then we -- then we 23 can -- we can break. 24 MS. O'DELL:</p>	<p style="text-align: right;">Page 236</p> <p>1 Q Okay. Do you have the marked document 2 in front of you? 3 Okay. If you look at the report, the 4 first document you cite to is JNJ_00030983. And 5 do you agree that's the document I've put in 6 front of you? 7 A I don't know. It doesn't look like it. 8 Oh, wait a minute. 9 Q Look at the very -- the very bottom 10 right. 11 A Yeah. There's three different sets of 12 numbers on this thing. I'm not even sure this is 13 the right document. 14 MS. O'DELL: 15 That -- 16 MR. FROST: 17 Q Well, that's what I was gonna say is 18 that I can tell you this is the document that was 19 produced as JNJ_00030983. And you agree with me 20 this is -- appears to be an epidemiological 21 study, not a -- not a mining study; correct? 22 A Yeah. And this is -- this is my fear 23 all the way through here, you know. When I've 24 gotten multiple Bates numbers on things, I have</p>
<p style="text-align: right;">Page 235</p> <p>1 Yeah. If we could break at 2:50 -- 2 MR. FROST: 3 Yeah. 4 MS. O'DELL: 5 -- that would be -- because I need 6 to -- 7 MR. FROST: 8 Yeah. I think we can get through the 9 next set of documents in five minutes. Should -- 10 MS. O'DELL: 11 Okay. 12 MR. FROST: 13 I should be able to do it. 14 MS. O'DELL: 15 I need -- we need a little bit of time 16 to get -- 17 MR. FROST: 18 Yeah. No. I get it. 19 MS. O'DELL: 20 -- prepared for the call to the court. 21 Thank you. 22 (DEPOSITION EXHIBIT NUMBER 15 23 WAS MARKED FOR IDENTIFICATION.) 24 MR. FROST:</p>	<p style="text-align: right;">Page 237</p> <p>1 to pick one. And this -- I don't think this is a 2 document that I've looked at. 3 Q Okay. 4 MS. O'DELL: 5 And, to be fair, it's -- it's -- this 6 is the -- what's been given to him is J&J, not J, 7 capital N, J. So it's not identical to what's in 8 his report. So I would just point that out. I'm 9 not sure if that's -- 10 MR. FROST: 11 No, no. Look at the very bottom 12 number, JNJ, bottom right hand. 13 MS. O'DELL: 14 Oh, I see. But still, I'm not sure 15 that -- that -- it's not underscore. So I -- I 16 don't believe it's the same one. But if there's 17 an error on the Bates number, we'll address that. 18 MR. FROST: 19 I will say as production, this is the 20 one that matches the JNJ_, et cetera. 21 I have marked this one as the next one. 22 (DEPOSITION EXHIBIT NUMBER 16 23 WAS MARKED FOR IDENTIFICATION.) 24 MR. FROST:</p>

<p style="text-align: right;">Page 238</p> <p>1 Q I think you're gonna recognize this</p> <p>2 document. So this is the second document in the</p> <p>3 series.</p> <p>4 A I am gonna recognize it?</p> <p>5 Q JNJ000016791.</p> <p>6 A Yeah.</p> <p>7 Q Again, this is a --</p> <p>8 A Something's screwed up.</p> <p>9 Q Seems to be a better copy of the same</p> <p>10 document.</p> <p>11 A Yeah.</p> <p>12 Q Okay. All right. Move on to the next</p> <p>13 one which is cited, which is the JNJ60592.</p> <p>14 (DEPOSITION EXHIBIT NUMBER 17</p> <p>15 WAS MARKED FOR IDENTIFICATION.)</p> <p>16 A Okay.</p> <p>17 MR. FROST:</p> <p>18 Q Okay. You'll agree with me that this</p> <p>19 document talks about the presence of quartz.</p> <p>20 Nowhere does it talk about the presence of</p> <p>21 fibrous amphiboles.</p> <p>22 A Correct.</p> <p>23 Q Okay. Move on to the next one, tab --</p> <p>24 which is JNJ238194.</p>	<p style="text-align: right;">Page 240</p> <p>1 quality, purity, uniformity and reliability of</p> <p>2 supply, outstanding performance for many years</p> <p>3 when compounded into Johnson's baby powder."</p> <p>4 A Right.</p> <p>5 Q Okay. All right. This last one I'll</p> <p>6 mark, and then we can break.</p> <p>7 So this is the Pooley report, which is</p> <p>8 JNJ322351.</p> <p>9 A Is this the long one or there's --</p> <p>10 there's multiply Pooley reports.</p> <p>11 Q Yeah, I believe this is the long one.</p> <p>12 A Okay.</p> <p>13 Q It's the one that deals with the</p> <p>14 Italian mines.</p> <p>15 A Yeah. Well, there are a number of</p> <p>16 them.</p> <p>17 Q Yeah. There's one that's extremely</p> <p>18 short --</p> <p>19 A Yeah.</p> <p>20 Q -- and then there's the longer one.</p> <p>21 This is the longer of the two.</p> <p>22 (DEPOSITION EXHIBIT NUMBER 19</p> <p>23 WAS MARKED FOR IDENTIFICATION.)</p> <p>24 MR. FROST:</p>
<p style="text-align: right;">Page 239</p> <p>1 Sorry. What number are we on?</p> <p>2 THE COURT REPORTER:</p> <p>3 18.</p> <p>4 MR. FROST:</p> <p>5 18.</p> <p>6 (DEPOSITION EXHIBIT NUMBER 18</p> <p>7 WAS MARKED FOR IDENTIFICATION.)</p> <p>8 MR. FROST:</p> <p>9 Q And, again, if you want, I can give you</p> <p>10 time to look at it. But, specifically, we're</p> <p>11 talking about Italy, which is on the first page.</p> <p>12 My question here is, again, this</p> <p>13 document nowhere mentions fibrous amphiboles or</p> <p>14 fibrous serpentines with respect to the -- the</p> <p>15 ore; correct?</p> <p>16 A Hang on a sec. Let me look that up. I</p> <p>17 don't think that this is the document I was</p> <p>18 referencing. Huh-uh. Hang on.</p> <p>19 Yeah. I don't think that's the right</p> <p>20 document.</p> <p>21 Q Okay. And, in fact, if we're looking</p> <p>22 at this document, under Category 1, "Maximum</p> <p>23 Confidence," which includes the Italian ore, it</p> <p>24 states, quote, "Long experience of established</p>	<p style="text-align: right;">Page 241</p> <p>1 Q And I'll first address your attention</p> <p>2 to page 6 of the report.</p> <p>3 A Okay.</p> <p>4 Q The bottom paragraph, he sort of --</p> <p>5 it's the summary of what he's doing.</p> <p>6 A Hang on. I may have the wrong page.</p> <p>7 All right. I've got it.</p> <p>8 Q Okay. The second sentence is,</p> <p>9 "Numerous photomicrographs taken under PPL and XN</p> <p>10 are provided with the descriptions to illustrate</p> <p>11 the rock textures, which it is hoped will provide</p> <p>12 information useful to the continuing" -- or --</p> <p>13 A I'm sorry, Jack. Show me the --</p> <p>14 Q Sure. It's --</p> <p>15 A You say it's page 6?</p> <p>16 Q Page 6.</p> <p>17 A Okay. All right. I've got it.</p> <p>18 MS. O'DELL:</p> <p>19 I'm on a different page 6, so give me</p> <p>20 just a minute.</p> <p>21 MR. FROST:</p> <p>22 Sure. It says "page 6" at the top.</p> <p>23 Q Must be more full page sixes.</p> <p>24 A Yeah, I think there may be.</p>

<p style="text-align: right;">Page 242</p> <p>1 Q One, two, three, four, five --</p> <p>2 MS. O'DELL:</p> <p>3 The page 6 I have, it's -- it's got a</p> <p>4 picture on it. So it's not what you're --</p> <p>5 MR. FROST:</p> <p>6 So it's the ninth page in.</p> <p>7 MS. O'DELL:</p> <p>8 And I'm sorry. It's right before our</p> <p>9 call with the Court.</p> <p>10 MR. FROST:</p> <p>11 Yeah, that's fine. We can pause here.</p> <p>12 VIDEOGRAPHER:</p> <p>13 Going off the record. The time is</p> <p>14 12:53 p.m.</p> <p>15 (OFF THE RECORD.)</p> <p>16 VIDEOGRAPHER:</p> <p>17 We're back on the record. The time is</p> <p>18 1:48 p.m.</p> <p>19 MR. FROST:</p> <p>20 Q Okay. Welcome back from lunch, sir.</p> <p>21 So we were on page 6 of the Pooley</p> <p>22 report.</p> <p>23 A Okay. Right.</p> <p>24 Q I believe you're on the correct page.</p>	<p style="text-align: right;">Page 244</p> <p>1 MR. FROST:</p> <p>2 Yeah, the entire exhibit.</p> <p>3 Q Look at the bottom paragraph. On --</p> <p>4 Sorry. On the page on the left.</p> <p>5 Okay. The second sentence down says,</p> <p>6 "The only asbestos-type mineral to be detected in</p> <p>7 the Hamm samples was tremolite, which was found</p> <p>8 in three of the specimens. The tremolite was</p> <p>9 associated" --</p> <p>10 Under our conclusion.</p> <p>11 -- "with carbonate minerals, mainly</p> <p>12 magnesite and calcite. No tremolite was detected</p> <p>13 in the talc-typed specimens."</p> <p>14 A Okay.</p> <p>15 Q And, then, if you go to the</p> <p>16 second-to-last paragraph of the paper --</p> <p>17 A Okay.</p> <p>18 Q -- towards the bottom of that paragraph</p> <p>19 it reads, "Particles formed of the amphibole</p> <p>20 mineral found at the mine were hardly fibrous in</p> <p>21 character, the majority of the tremolite breaking</p> <p>22 in -- breaking to give compact particles."</p> <p>23 A Uh-huh.</p> <p>24 Q I read it poorly, but did I read it</p>
<p style="text-align: right;">Page 243</p> <p>1 A Uh-huh.</p> <p>2 Q Okay. The bottom paragraph?</p> <p>3 A Right.</p> <p>4 Q Okay. It's talking about the report,</p> <p>5 and it says, "Numerous photomicrographs taken</p> <p>6 under PPL and XN are provided with the</p> <p>7 description to mainly illustrate the rock</p> <p>8 textures, which it is hoped will provide</p> <p>9 information useful in the" --</p> <p>10 That's a tough one.</p> <p>11 -- "continuation" --</p> <p>12 A Right.</p> <p>13 Q -- "of particular -- of particularly</p> <p>14 the talc ore samples and also displays the</p> <p>15 nonoccurrence of asbestiform amphiboles in the</p> <p>16 talc ore."</p> <p>17 Did I read that correctly?</p> <p>18 A Yes.</p> <p>19 Q And if you turn to the last two</p> <p>20 pages --</p> <p>21 A The last two?</p> <p>22 Q Yeah, the last two.</p> <p>23 MS. O'DELL:</p> <p>24 Of the entire exhibit?</p>	<p style="text-align: right;">Page 245</p> <p>1 right?</p> <p>2 MS. O'DELL:</p> <p>3 Object to the form.</p> <p>4 A Right. I've read it.</p> <p>5 MR. FROST:</p> <p>6 Q Okay. So do you agree with me that the</p> <p>7 Pooley report does not mention finding any</p> <p>8 fibrous materials at the -- the Italian mine?</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 A Yeah.</p> <p>12 This isn't the only Pooley report.</p> <p>13 MR. FROST:</p> <p>14 Q This is the one that's cited in your</p> <p>15 report on --</p> <p>16 A Right. There's more --</p> <p>17 Q -- page 10; correct?</p> <p>18 A There's more than one. But I think</p> <p>19 that in the material that you read, he doesn't --</p> <p>20 does not mention fibrous tremolite.</p> <p>21 Q You'd agree this is the document that</p> <p>22 starts JNJ000322351 that you cite in your report</p> <p>23 on page 10?</p> <p>24 A Right. That's that one.</p>

<p style="text-align: right;">Page 246</p> <p>1 Q Okay.</p> <p>2 Great. Sorry. I've got to reorient</p> <p>3 myself where I am in your report. If you'll give</p> <p>4 me a second.</p> <p>5 A It's all right.</p> <p>6 VIDEOGRAPHER:</p> <p>7 Jack, do you have your mic on?</p> <p>8 MR. FROST:</p> <p>9 I do not.</p> <p>10 Q Page 10, we're under "Italy." So about</p> <p>11 halfway through your paragraph, you have a</p> <p>12 sentence that reads, "Chrysotile is also reported</p> <p>13 in the Val Chisone mineral suite in 1971 by</p> <p>14 Ashton."</p> <p>15 A Right.</p> <p>16 Q And you cite JNJAZ55-6103.</p> <p>17 I've got that document.</p> <p>18 A And he's got a list of minerals kind of</p> <p>19 in the middle of -- in the middle of the page</p> <p>20 there, and chrysotile, I think, is mentioned.</p> <p>21 Right.</p> <p>22 (DEPOSITION EXHIBIT NUMBER 20</p> <p>23 WAS MARKED FOR IDENTIFICATION.)</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 248</p> <p>1 Object to the form.</p> <p>2 MR. FROST:</p> <p>3 Q Because it continues, "And the minerals</p> <p>4 we'll show in the valley are."</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A Well, the valley is where the mine is.</p> <p>8 MR. FROST:</p> <p>9 Q Okay. But he's not saying that he has</p> <p>10 found talc, pyrite, magnesite, calcite, dolomite,</p> <p>11 apatite, clinochlore, chrysotile, tourmaline,</p> <p>12 tremolite, actinolite, aluminite, and albite all</p> <p>13 in the Fontane mine ore; correct?</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 A Well, I'm -- I'm not sure that he even</p> <p>17 relates Fontane in that paragraph at all.</p> <p>18 MR. FROST:</p> <p>19 Q Exactly. He's just talking about the</p> <p>20 mineralization of the valley --</p> <p>21 A That's right.</p> <p>22 Q -- correct?</p> <p>23 A But Fontane's in the valley.</p> <p>24 Q Yes. But there are lots of other</p>
<p style="text-align: right;">Page 247</p> <p>1 Q Yeah, it's -- you're talking about</p> <p>2 where the -- the arrow is on the paper?</p> <p>3 A Correct.</p> <p>4 Q And you'd also agree with me that</p> <p>5 he's -- he's talking about the valley, what --</p> <p>6 mineralizations in the valley. He's not talking</p> <p>7 about the Fontane ore or mine specifically;</p> <p>8 correct?</p> <p>9 A He might have been.</p> <p>10 Q But there's no way to tell by this</p> <p>11 document; correct?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form.</p> <p>14 A Well, this is a general comment about</p> <p>15 the location.</p> <p>16 MR. FROST:</p> <p>17 Q Okay. And he's talking about, "I have</p> <p>18 checked into the mineralization of the part of</p> <p>19 the territory"; correct?</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 MR. FROST:</p> <p>23 Q He's talking about the valley?</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 249</p> <p>1 places in the valley that aren't the Fontane</p> <p>2 mass; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A That's right. But I don't know why</p> <p>6 he'd be interested in them.</p> <p>7 MR. FROST:</p> <p>8 Q So you're telling me, by reading this,</p> <p>9 you couldn't relate to the fact that he's found</p> <p>10 all of these and they're associated with the</p> <p>11 Fontane mine because that mine is located in that</p> <p>12 valley?</p> <p>13 A I think if you read what's been</p> <p>14 published about this, what you find is that the</p> <p>15 host rocks that contain the carbonate sequence</p> <p>16 with the talc in it is rich in some of these.</p> <p>17 Q Okay. And, again, you're --</p> <p>18 A So he's probably --</p> <p>19 And I'm, once again, I'm making an</p> <p>20 assumption. I don't think he'd go out and decide</p> <p>21 that he'd go up to the rim of the valley and</p> <p>22 collect a bunch of rocks that have nothing to do</p> <p>23 with -- with J&J or who he was working for.</p> <p>24 But, you know, I think that the list of</p>

<p style="text-align: right;">Page 250</p> <p>1 minerals here could be extended out to the edges 2 of -- of the ore body. And if you went to the 3 Fontane mine, went underground, you could 4 probably find these minerals in the ore body but 5 next to the host rocks because -- 6 Q Okay. 7 A Well, anyway, this is a pretty 8 extensive suite. And -- and the reason I say 9 that is tourmaline is not a mineral that you 10 would see in a -- in a talc ore body, but it 11 would occur next to one. 12 Q So I've heard in your answer a lot of 13 "I guess, I suppose." I mean, you can't sit here 14 and tell me that, "Yeah, this shows the 15 chrysotile is associated with the Fontane ore 16 body"; correct? 17 MS. O'DELL: 18 Object to the form. 19 A Well, it has to be associated with 20 whatever processes took place that would form 21 chrysotile. And it wouldn't be in the enclosing 22 schists. I mean, that -- that's just not the 23 right locale. 24 MR. FROST:</p>	<p style="text-align: right;">Page 252</p> <p>1 any talc from the Italian mines; correct? 2 A There is a document that says that they 3 were considering using it again. 4 Q Okay. 5 A And it's in that time period. 6 Q But, again, they weren't using it. 7 They were considering using it. 8 A To my knowledge, they weren't. 9 Q Okay. And, to this day, you're 10 aware -- I think you say in your report from '03 11 to today they used Chinese talc. Correct? 12 A That's my -- my understanding. 13 Q Skipping down, next couple sentences, 14 it says, "A paper describing asbestos in Italian 15 talc deposits was published by Marconi and Verdel 16 in 1990." 17 A Okay. 18 Q Do you recall that? 19 A Yeah, I recall the reference, sure. 20 Q Do you recall whether or not they say 21 that there's any asbestos found in the Fontane 22 mine deposit? 23 A I'm not sure they say that 24 specifically.</p>
<p style="text-align: right;">Page 251</p> <p>1 Q So, again, my -- my question is just 2 because it says "chrysotile" in this document 3 doesn't mean there's chrysotile in the ore at 4 Fontane; correct? 5 MS. O'DELL: 6 Object to the form. 7 A Yeah. He doesn't say -- 8 MR. FROST: 9 Q Okay. 10 A He doesn't specifically say the Fontane 11 mine. 12 Q Okay. And, again, I think you -- 13 tourmaline, you pointed out, wouldn't even be 14 associated with the talc. 15 A You wouldn't -- you wouldn't think so. 16 Q Okay. Moving on, on page 10 you note 17 that "Fibrous tremolite" -- 18 Do you see where I am? It's another 19 sentence down. 20 "Fibrous tremolite was reported from 21 Italian talc as late as 2009." 22 A Correct. 23 Q Okay. And you agree with me that, by 24 2009, Johnson & Johnson certainly wasn't sourcing</p>	<p style="text-align: right;">Page 253</p> <p>1 Q Okay. I'll mark it. I'll show it to 2 you. 3 (Technical difficulties) 4 THE COURT REPORTER: 5 Do you want to go off the record? 6 MR. FROST: 7 Yeah, I was gonna say, let's go off the 8 record. 9 VIDEOGRAPHER: 10 Going off the record. The time is 11 1:57 p.m. 12 (OFF THE RECORD.) 13 VIDEOGRAPHER: 14 We're back on the record. The time is 15 1:58 p.m. 16 MR. FROST: 17 Q Okay. We are marking the Marconi and 18 Verdel Exhibit 21. 19 (DEPOSITION EXHIBIT NUMBER 21 20 WAS MARKED FOR IDENTIFICATION.) 21 MR. FROST: 22 Q And I'll -- I'm specifically looking at 23 pages 109, 110. 24 A Okay.</p>

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1 Q At the very bottom of 109 -- of 109,
2 the section called "Results and Discussion."
3 A Right.
4 Q And it says, "Sample still in
5 production does not show the presence of
6 serpentine or tremolite amphibole minerals."
7 Did I read that correctly?
8 A Yes.
9 Q If you turn over to 110, if you look at
10 Table 1, which is the mean mineralogy composition
11 of talcs from active Italian mines, the first one
12 is the Fontane mine in Piedmont; right?
13 A Right.
14 Q Okay. On page 11 of your report, in
15 that first paragraph we're now -- we've moved on
16 to the Vermont deposits.
17 A Okay.
18 Q And, at the end of that -- that first
19 paragraph, there's a sentence that says, "These
20 include the Carlton talc mine in Chester, Windsor
21 County, and other Vermont serpentinite-related
22 actinolite or tremolite occurrences as documented
23 by Seymour" -- you have (J&J 53200) -- "at
24 Hammondsville, the Barton steatite quarry, Holden

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1 talc quarry, Rochester verde antique quarry, and
2 Mad River mine."
3 I've read it, again, poorly, but did I
4 read it correctly?
5 A Right. Well, and, in all fairness,
6 this is a paragraph that I began to take material
7 out of to add to tables.
8 Q Okay.
9 A So it may read herky-jerky because of
10 that. You know, it doesn't -- it doesn't flow as
11 brilliantly as it did when I first wrote it.
12 Q Okay. I'm not gonna -- I won't
13 question you on that.
14 A Okay.
15 Q Do you agree with me that the Seymour
16 report only relates to the East Johnson mine in
17 particular? I can mark it if you want me to.
18 A He actually mentions some other mines
19 in it, but just giving them as examples of other
20 locations. And he mentions little mineralogy.
21 But his thesis is the Johnson mine.
22 Q Okay. And you agree with me that the
23 paper nowhere -- the paper nowhere mentions the
24 Hammondsville mine; correct?

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1 MS. O'DELL:
2 Object.
3 MR. FROST:
4 Q And, again, I can --
5 A Wow.
6 Q I can mark it if you want.
7 A That's a long thesis.
8 Q It's a very long paper.
9 A I'm not saying that somewhere in there
10 he doesn't say Hammondsville, but he doesn't --
11 he doesn't present any significant information
12 about Hammondsville.
13 Q Okay. Well, it's a happy medium. I
14 can tell you that the word "Hammondsville" is not
15 there --
16 A Okay.
17 Q -- but you agree with me he's certainly
18 not talking specifically about the Hammondsville
19 geology?
20 A No.
21 MS. O'DELL:
22 Object to the form.
23 A Yeah. He -- he's not talking about
24 geology at the Hammondsville mine. The geology

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1 may be quite similar.
2 MR. FROST:
3 Q Okay.
4 A But he's not --
5 Q He's not focusing on the geology of
6 Hammondsville.
7 A Right.
8 Q Do you know whether or not commercial
9 asbestos was ever mined from either
10 Hammondsville, Hamm, Argonaut, or the Rainbow
11 mines?
12 A I don't think it was ever mined from
13 that north-south trend at Ludlow.
14 Q Okay.
15 A I'm not sure about Hammondsville.
16 The -- the Hammondsville deposit is pretty large,
17 and it -- you know, it was mined underground, and
18 I don't have a reference that says that it was.
19 Q Okay. That was my next question.
20 Sitting here, you certainly can't point me to
21 anything that ever says Hammondsville was used as
22 an asbestos mine; right?
23 A I don't have a reference to that.
24 On the other hand, it would be

<p style="text-align: right;">Page 258</p> <p>1 interesting to -- to actually do an asbestos 2 study for the same areas that we've done a talc 3 study for. And I actually have not done that. 4 In fact, I was surprised when I found 5 that talc had been mined on Belvidere Mountain. 6 I was surprised. 7 So, you know, it's not impossible that 8 at some point in time there was asbestos mined 9 somewhere near Hammondsville in the same rock 10 unit. 11 Q You don't know one way or the other -- 12 A No. 13 Q -- sitting here today? 14 All right. Still on page 11 of your 15 report, you note -- it's the paragraph that 16 starts "A literature review for Vermont talc." 17 A Okay. 18 MS. O'DELL: 19 Still on page 11? 20 MR. FROST: 21 Yes, still on page 11. 22 Q Sorry. 23 A It's all right. 24 Q Trying to orient myself. I apologize.</p>	<p style="text-align: right;">Page 260</p> <p>1 Yep. 2 (DEPOSITION EXHIBIT NUMBER 22 3 WAS MARKED FOR IDENTIFICATION.) 4 MR. FROST: 5 Q I don't believe this report is on your 6 literature list. Is that correct? 7 A I certainly have it. I'm not sure 8 whether I used it or not. I don't believe I did, 9 but -- but I could have. 10 If I had used it, I would have probably 11 been referencing maybe some of the other similar 12 deposits elsewhere than -- or elsewhere than 13 Vermont. 14 Q Okay. Quickly, if you turn to page 49 15 of this document. 16 A Okay. 17 MS. O'DELL: 18 And if you need a minute to take a look 19 at it, Dr. Cook, feel free to do that. 20 MR. FROST: 21 Q Although I promise you the question is 22 really easy. 23 MS. O'DELL: 24 Well, but --</p>
<p style="text-align: right;">Page 259</p> <p>1 I can't find where it is in your 2 report -- bear with me -- but one of the 3 publications you rely on in your report is the 4 Chidester 1951 USGS survey. Does that ring a 5 bell? I'm sure I'm saying it wrong. 6 A Chidester, Billings and Cady? 7 Q Yes. I've got it. 8 A Okay. 9 Q And do you agree with me that the 10 Hammondsville mine in particular is called out in 11 his report? Correct? 12 A He mentions it very briefly. 13 Q And you agree with me that nowhere does 14 Chidester mention the occurrence of asbestos 15 associated with the Hammondsville mine; correct? 16 MS. O'DELL: 17 Object to the form. 18 A That's correct. 19 MR. FROST: 20 Q And, then, I believe the Chidester 64 21 document is also on -- 22 I'm gonna mark this document. I 23 believe we're on 22. 24 THE COURT REPORTER:</p>	<p style="text-align: right;">Page 261</p> <p>1 MR. FROST: 2 Q No. No, but I agree. If you need time 3 to read it, please take your time. 4 A Yeah. Go ahead. 5 Q So if you look at the Table 22, if you 6 look below -- 7 A Right. 8 Q -- you agree with me that 40A, 40B, and 9 40C are all testing of products that have come 10 from the Hammondsville quarry; correct? 11 A Looks that way. 12 Q Okay. 13 A These are chemical analyses. I think 14 that I'm looking at the right table. 15 Q Yes, you're looking at the right table. 16 A Okay. 17 Q But I'm just noting that, you know, 18 here's another Chidester article where USGS is 19 specifically looking at the Hammondsville quarry. 20 You agree with me on that one; right? 21 A Yes. 22 Q If you look -- I think you mentioned 23 NIOSH earlier this morning; correct? You're at 24 least aware who NIOSH is?</p>

<p style="text-align: right;">Page 262</p> <p>1 MS. O'DELL: 2 I don't think he's mentioned NIOSH, 3 but -- 4 MR. FROST: 5 Q I thought you had. But do you know who 6 NIOSH is? 7 A Right. 8 Q And are you aware that NIOSH did an 9 epidemiological study of talc miners working at 10 the various Vermont talc plants? 11 A I know it exists. I don't know the 12 results. 13 Q Okay. And are you aware the reason 14 that NIOSH specifically chose the Vermont talc 15 mines for purposes of the study? 16 A No. 17 Q Were you ever aware that NIOSH chose 18 them because they believed those talc mines to be 19 asbestos-free? 20 MS. O'DELL: 21 Objection to form. 22 MR. FROST: 23 Q And if you haven't, okay. 24 A No, I didn't know that.</p>	<p style="text-align: right;">Page 264</p> <p>1 A This is -- it's kind of interesting 2 that they would write this paper. 3 MR. FROST: 4 Q Why is that? 5 A Well, the title, it -- it suggests that 6 they're willing to accept the fact that 7 asbestiform talc exists. 8 Q Okay. But if you turn to page 377, 9 under "Conclusions" -- 10 A Uh-huh. 11 Q Do you see where I am? 12 A Yep. 13 Hang on a sec. I can't make the pages 14 turn for me. Hang on a sec. 15 MS. O'DELL: 16 Yeah. Take a minute if you -- since 17 you haven't seen it, Doctor, if you need to look 18 at it, feel free to take a look at it. 19 A Have you noticed that half the 20 documents we've got don't have dates on them? 21 MR. FROST: 22 Q I have, actually. 23 A Have you noticed that? It's the most 24 irritating thing.</p>
<p style="text-align: right;">Page 263</p> <p>1 MR. FROST: 2 I'm gonna mark another exhibit. 3 MS. O'DELL: 4 23? 5 MR. FROST: 6 No. That's 22. No, 23. You're right. 7 (DEPOSITION EXHIBIT NUMBER 23 8 WAS MARKED FOR IDENTIFICATION.) 9 MR. FROST: 10 Q So on the fourth piece of paper, which 11 is probably the eighth page into -- I guess the 12 seventh page, it shows a paper or a study called 13 "Occupational exposures to non-asbestiform talc 14 in Vermont" by Boundy. 15 A Right. 16 Q Have you ever seen this paper before? 17 A I don't think so. 18 I don't think I referenced it, did I? 19 Q No. It's not in a reference. 20 A Huh-uh. I don't think I've seen it. 21 Q Okay. 22 MS. O'DELL: 23 If you need to take a minute and look 24 at it, Doctor, feel free to.</p>	<p style="text-align: right;">Page 265</p> <p>1 Q I have noticed that. 2 A See, this is a 1979 document. 3 Q That's correct. 4 A And yet their -- the title is 5 forward-looking. 6 Q So, again, once you're done looking at 7 it, I'm on page 377. 8 A Yeah, I'm there. I'm -- 9 Q Okay. You see under the first sentence 10 it says, "The Vermont talc industry was selected 11 by NIOSH for both epidemiological and 12 environmental surveys to distinguish a TWA dust 13 exposure because this talc is believed to contain 14 minimal amounts of quartz and asbestos." 15 And then if you look at the bottom 16 sentence, that paragraph, "Petrographic 17 microscopy analysis, analytical transmission 18 electron microscopy, and x-ray diffraction with 19 step scanning revealed no asbestos in the bulk 20 samples." 21 Correct? 22 MS. O'DELL: 23 That's what it states. 24 MR. FROST:</p>

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<p>1 Q That's what it states?</p> <p>2 A That's what it states. But in the</p> <p>3 first thing that you read, it says minimum --</p> <p>4 minimal amounts.</p> <p>5 Q Of, quotes, in asbestos.</p> <p>6 A Right. I would question, you know,</p> <p>7 whether some of those analytical techniques are</p> <p>8 sufficient to say there's no asbestos.</p> <p>9 Q So you believe that TEM is</p> <p>10 insufficient?</p> <p>11 A TEM, I think, is -- is okay.</p> <p>12 Q Okay.</p> <p>13 A But I don't think XRD is.</p> <p>14 Q Okay. But, again, analytical</p> <p>15 transmission electron microscopy, that's TEM;</p> <p>16 right?</p> <p>17 A It is. But, now, that's gonna tell you</p> <p>18 the -- the mineralogy of a specific particle.</p> <p>19 Q Okay.</p> <p>20 A One particle. Okay?</p> <p>21 Q Sure. But you agree that TEM is a</p> <p>22 proper --</p> <p>23 A Well, the point is that they can't have</p> <p>24 analyzed a lot of -- a lot of samples because</p>	<p>1 mentioned in those mines in the mineral index of</p> <p>2 Vermont, which, you know, it isn't complete, but</p> <p>3 I think that it's a useful thing to cite.</p> <p>4 So, no, I can't think of any in the</p> <p>5 published literature. They may exist. I'm just</p> <p>6 drawing a blank right now.</p> <p>7 Q Okay. All right. So turn to page 11,</p> <p>8 sir, of your report.</p> <p>9 A Okay.</p> <p>10 Q You state, about halfway through,</p> <p>11 "Amphibole in amounts less than .1 percent were</p> <p>12 found in float feed in Hamm mine ore as reported</p> <p>13 in a product certification report in 1992."</p> <p>14 And then you cite Imerys 151337.</p> <p>15 A Hopefully, that's the right report.</p> <p>16 MR. FROST:</p> <p>17 Mark this as 24.</p> <p>18 (DEPOSITION EXHIBIT NUMBER 24</p> <p>19 WAS MARKED FOR IDENTIFICATION.)</p> <p>20 MR. FROST:</p> <p>21 Here you are.</p> <p>22 Q And, again, you'll agree with me this</p> <p>23 is not a product certification?</p> <p>24 A No. This is a -- not something I've</p>
Page 267	Page 269
<p>1 it's too time-consuming and too expensive. So</p> <p>2 the fact that they didn't find any asbestos with</p> <p>3 TEM is, you know, that's interesting.</p> <p>4 Q And, again, that's just speculating</p> <p>5 because I'm looking at this sentence, how much</p> <p>6 they looked at and what they looked at.</p> <p>7 A Right.</p> <p>8 Q Okay. Okay. Can you point me to any</p> <p>9 specific geology studies or reports in the</p> <p>10 published literature that show there's any</p> <p>11 asbestos at the Hammondsville, Hamm, Argonaut, or</p> <p>12 Rainbow mines?</p> <p>13 A In the published literature?</p> <p>14 Q Yes, in the published literature.</p> <p>15 A No.</p> <p>16 Q Okay. Turn to page 11 of your report.</p> <p>17 A Let me -- I'm still thinking about my</p> <p>18 very rapid "no" response. We were mine-specific.</p> <p>19 I'm thinking about -- back about the US</p> <p>20 Geological Survey's database. I don't think</p> <p>21 there -- that they have pointed out asbestos in</p> <p>22 those mines. I don't think they have. They have</p> <p>23 in some, but I don't think those were -- were</p> <p>24 mentioned. I don't think that asbestos was</p>	<p>1 seen before.</p> <p>2 Q Okay. And this certainly doesn't talk</p> <p>3 about amphibole found in float feeder in the</p> <p>4 mine?</p> <p>5 A No.</p> <p>6 Q Okay. Turn to page 12. The top</p> <p>7 paragraph, it says, "Concern with incorporating</p> <p>8 serpentine and lampr- --"</p> <p>9 A Lamprophyre.</p> <p>10 Q -- "lamprophyre" --</p> <p>11 A Uh-huh.</p> <p>12 Q -- "from dikes in processed Vermont ore</p> <p>13 was expressed in 2006" --</p> <p>14 A Right.</p> <p>15 Q -- "suggesting a maximum of 2 percent</p> <p>16 for serpentine."</p> <p>17 Do you also agree with me that by '06</p> <p>18 Johnson & Johnson was no longer using Vermont</p> <p>19 talc? Correct?</p> <p>20 A Right. They were using it but not for</p> <p>21 cosmetic talc.</p> <p>22 Q Not for cosmetic talcum powder.</p> <p>23 A It was industrial.</p> <p>24 Q Right.</p>

<p style="text-align: right;">Page 270</p> <p>1 A You know, the reason I had that in my 2 report was -- 3 MS. O'DELL: 4 Go ahead. 5 THE WITNESS: 6 He's not listening. 7 MR. FROST: 8 Q I'm listening, sir. 9 A Are you? 10 Q Okay. Yes. 11 A -- was that there's no indication that 12 there was a dramatic change in geology at 13 Argonaut and, so, we know that the lamprophyre 14 dikes are -- are pretty prevalent there. So I'm 15 just pointing out once again that there, you 16 know, there are things that are there that could 17 have been in the ore from the start. 18 Q Okay. But, again, you know, we're 19 using "could have." We're just sort of guessing 20 at this point. 21 A Right. 22 MS. O'DELL: 23 Object to the form. 24 MR. FROST:</p>	<p style="text-align: right;">Page 272</p> <p>1 mineral. Every mineral's got multiple peaks. 2 And, so, if you've got a sample that's 3 got, let's say, talc, magnesite, and some 4 chlorite, you can have a very complicated x-ray 5 diffractogram and, unfortunately, there is 6 interference with some of the characteristic 7 peaks, particularly for chrysotile. I mean, you 8 just -- you can't do chrysotile by XRD because 9 there are two or three things that interfere with 10 the very peak that you need to look at. 11 And, so, it's hard -- it's hard to get 12 to .1, I would say. But I'm willing to accept 13 that. But I've, in my experience, I have never 14 been able to get there. 15 Q Okay. You agree the published 16 literature says .1, give or take -- 17 A Yeah. 18 Q -- is the accepted level or the -- the 19 level of sensitivity of the instrument? 20 A It's there. That's mentioned. 21 Q And are you aware that the FDA 22 regulates talcum powder? 23 MS. O'DELL: 24 Object to the form.</p>
<p style="text-align: right;">Page 271</p> <p>1 Q All right. Further down on page 12 -- 2 it's the next paragraph -- you write (as read:) 3 "Screening talc ore samples for trace to small 4 amounts of specific amphibole series by X-ray 5 diffraction is not adequate because of its was 6 [sic] high detection limit." 7 Do you see that? 8 A Uh-huh. Yes. 9 Q And what's your basis for the 10 statement? 11 A Well, I have done I don't know how many 12 years of analytical work with x-ray diffraction, 13 and for my clients, I'm not willing to give it 14 below 1 percent. But there you -- they do use 15 step scanning, which is a repetitive process that 16 exaggerates the presence of a peak. I'm willing 17 to buy .1, but that's it. I mean, I don't think 18 you could possibly do it below that. 19 And it depends on the peaks that you're 20 using, because some of these -- some of these 21 rock units have got minerals -- 22 I mean, all of them have multiple 23 peaks. Okay? You're not just dealing with an 24 x-ray pattern that has a single peak for one</p>	<p style="text-align: right;">Page 273</p> <p>1 A I've read that. 2 MR. FROST: 3 Q Okay. And you're aware that, under the 4 FDA agreed-upon testing, that XRD testing of bulk 5 talcum powder is the first step? 6 A Yes. Yes. That's been the first step 7 for decades. 8 Q Okay. And we've already talked about 9 this, but you don't have an opinion or you're not 10 qualified to give an opinion as to whether or not 11 any amphibole materials that might exist in talc 12 below .1 percent detection level could be capable 13 of causing human disease; right? 14 MS. O'DELL: 15 Object to the form. 16 A No. 17 MR. FROST: 18 Q Okay. Further down on that page, you 19 start talking about chlorite. 20 It's over on page 12, Leigh, third 21 paragraph down. 22 You note, "Chlorite family species can 23 contain specific heavy metals such as chromium 24 and are consistently reported in core logs from</p>

<p style="text-align: right;">Page 274</p> <p>1 the Argonaut mine."</p> <p>2 Then you have a cite and the example of</p> <p>3 "chlorite content of 4.1 percent is reported for</p> <p>4 its ores in a reserve study produced in '08.</p> <p>5 Okay? And just because a level of</p> <p>6 chlorite shows up in the drilling core logs</p> <p>7 doesn't necessarily mean that it's in the talc</p> <p>8 that's used to produce the ore; correct?</p> <p>9 A Well, let me answer it in an</p> <p>10 interesting way. When you look at the analyses</p> <p>11 that we had --</p> <p>12 And, by the way, earlier when I said I</p> <p>13 hadn't seen a set of analyses that were in spec</p> <p>14 for the metals, I was referring to Vermont.</p> <p>15 Q Okay.</p> <p>16 A I mean, you know, China's usually in</p> <p>17 spec completely for metals.</p> <p>18 But if you look at the -- the analyses</p> <p>19 for Grade 66 talcum, if you have 99 percent talc,</p> <p>20 which is wonderful, there's still 1 percent</p> <p>21 something else. And that something else is</p> <p>22 probably a chlorite family mineral. That's</p> <p>23 probably the way you have got to explain that,</p> <p>24 that other 1 percent.</p>	<p style="text-align: right;">Page 276</p> <p>1 A Whatever.</p> <p>2 Q Still on page 12, but --</p> <p>3 A Yep. Yep.</p> <p>4 Q -- we'll move into China.</p> <p>5 A Thanks.</p> <p>6 Q You note at the second paragraph under</p> <p>7 the heading "China," quote, "There was a report</p> <p>8 of asbestos in Chinese talc in late 2009 (Imerys</p> <p>9 309326)." And then you state, "In 2016</p> <p>10 chrysotile particles were found in talc mined in</p> <p>11 China (JNJ52161)."</p> <p>12 All right. So let's look at those in</p> <p>13 turn. Let's start with the Imerys 309326.</p> <p>14 (DEPOSITION EXHIBIT NUMBER 25</p> <p>15 WAS MARKED FOR IDENTIFICATION.)</p> <p>16 MR. FROST:</p> <p>17 Q And I'll direct your attention to the</p> <p>18 last page.</p> <p>19 A Yeah. Got it.</p> <p>20 Q Okay. And I take it you're relying on</p> <p>21 the sentence about halfway through. It says,</p> <p>22 "Chinese authorities have informed J&J" --</p> <p>23 A Right.</p> <p>24 Q -- "that its internal testing contained</p>
<p style="text-align: right;">Page 275</p> <p>1 If it is a chlorite family mineral,</p> <p>2 then it's possible that these high metal numbers</p> <p>3 that you have may be related to the chlorite, at</p> <p>4 least in part. And that was -- that was the</p> <p>5 reason for my comment.</p> <p>6 Q Okay.</p> <p>7 A I'm -- I'm trying to explain some of</p> <p>8 the numbers.</p> <p>9 Q I understand.</p> <p>10 So it's more of a scientific</p> <p>11 analysis --</p> <p>12 A Right, exactly.</p> <p>13 Q -- of here's how you could explain some</p> <p>14 of the higher levels because they'd be associated</p> <p>15 with chlorite?</p> <p>16 A Right.</p> <p>17 Q Okay.</p> <p>18 MS. O'DELL:</p> <p>19 This is the document I think that he</p> <p>20 was asking you about.</p> <p>21 THE WITNESS:</p> <p>22 Okay.</p> <p>23 MR. FROST:</p> <p>24 Q All right. Gonna move on to China now.</p>	<p style="text-align: right;">Page 277</p> <p>1 asbestos in several talc body powers marketed in</p> <p>2 China, including two products from J&J."</p> <p>3 A Correct.</p> <p>4 Q Okay. Do you agree with me that it</p> <p>5 continues to read, "However, four independent</p> <p>6 Chinese laboratories using similar test method to</p> <p>7 the Chinese authorities did not find any</p> <p>8 asbestos. J&J approached RTM" --</p> <p>9 Which is Rio Tinto Minerals.</p> <p>10 A Yeah.</p> <p>11 Q -- "for help in the issue. RTM</p> <p>12 provided initial support in identifying potential</p> <p>13 drawback of the test method used by the Chinese</p> <p>14 authorities. Chinese authorities invited J&J and</p> <p>15 others concerned -- J&J, the other concerned talc</p> <p>16 body powder companies and the four independent</p> <p>17 Chinese laboratories whose asbestos test results</p> <p>18 were negative, to discuss and resolve the test</p> <p>19 method discrepancies."</p> <p>20 I read that right?</p> <p>21 A Yeah. Sure.</p> <p>22 Q Okay. So, again, you're not noting in</p> <p>23 here that there's a question as to whether or not</p> <p>24 the Chinese talc findings of chrysotile are</p>

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1 correct; right?

2 MS. O'DELL:

3 Object to the form.

4 A Well, sure. I mean, it's a report

5 of -- of asbestos in a particular sample. And it

6 doesn't mean you can't take more samples that are

7 asbestos-free.

8 MR. FROST:

9 Q Okay. And, again, do you know -- do

10 you know if the Chinese authorities ever had the

11 conversation with the various labs that tested

12 whether or not they ever came to the

13 determination that there truly was chrysotile?

14 A I think --

15 MS. O'DELL:

16 Excuse me.

17 Object to the form. Misstates the

18 record.

19 MR. FROST:

20 Q You can answer.

21 A I think that there is a whole series of

22 memoranda and reports that relate to, you know,

23 it was the bee in the bonnet here. And I don't

24 remember the exact details of who did what to

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1 whom, but I think in the end they decided that it

2 must have been a mistake.

3 Q Okay.

4 A They didn't prove it was a mistake, but

5 I think that that was the consensus.

6 Q That was the ultimate determination?

7 Okay.

8 A You know, I'm experienced with the

9 Chinese, and -- and, in the first place, they

10 would never report talc if it would damage their

11 competitive market for a product. They would

12 have never reported asbestos in talc. So it

13 seemed to me kind of odd that they -- that they

14 did it in the first place if there was any

15 question about it.

16 The -- the analytical equipment

17 available in China is, you know, some's good and

18 some's bad.

19 Q Okay. But, again, you agree -- you

20 know, your recollection is the ultimate

21 determination was that it was a mistake --

22 A It kind of --

23 Q -- it ---

24 MS. O'DELL:

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1 Excuse me. Just give me a second,

2 Jack.

3 MR. FROST:

4 Sure.

5 MS. O'DELL:

6 Were you finished? I apologize. I was

7 trying to get --

8 MR. FROST:

9 Yeah. You can object.

10 MS. O'DELL:

11 Object to the form. Misstates the

12 record.

13 MR. FROST:

14 Q Okay.

15 A Yeah. I don't remember exactly what

16 the -- the resolution was, but I don't think

17 everybody quit -- quit using the Chinese talc

18 because of the -- the results of that -- of that

19 test.

20 Q All right.

21 A But it doesn't -- to me, it doesn't

22 mean there was no asbestos.

23 Q Okay. I'm gonna mark JNJ52616.

24 (DEPOSITION EXHIBIT NUMBER 26

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1 WAS MARKED FOR IDENTIFICATION.)

2 A For -- you know, let me just give you

3 an example. If these people determined asbestos

4 with XRD, it's a pretty good chance that it was

5 certainly higher than .1. I would guess that

6 their equipment wouldn't -- wouldn't get it down

7 that low. So they must have -- they must have

8 seen something.

9 MR. FROST:

10 Q But, again, you're only guessing at

11 this point; correct?

12 A Yeah, I'm guessing.

13 MS. O'DELL:

14 Object to the form.

15 MR. FROST:

16 Q All right. Let's look at the document

17 that's marked 26. And if you turn to the second

18 page under Section 3, "Observation," about

19 halfway down the last full paragraph in that --

20 that box, it states, "The samples were reprepared

21 and analyzed on 2-22-2016. It indicated the

22 sample and ID number 3138494 had multiple

23 chrysotile particles. Reproduction could not

24 duplicate the original results."

<p style="text-align: right;">Page 282</p> <p>1 I take it that's the section of this</p> <p>2 document you're relying on --</p> <p>3 A Yes.</p> <p>4 Q -- to say that chrysotile was found in</p> <p>5 2016?</p> <p>6 A Yes.</p> <p>7 Q Okay. If you turn over to the next</p> <p>8 page.</p> <p>9 A Can I make a comment about that?</p> <p>10 Q Sure.</p> <p>11 A It's amazing how many reanalyses end up</p> <p>12 with nothing in them. And unless you know how</p> <p>13 they're re- -- resampling and reanalyzing, you're</p> <p>14 really not sure what's going on here. If they</p> <p>15 had a split of the original sample and came up</p> <p>16 with nothing when the first split had something,</p> <p>17 they should have run it a third time.</p> <p>18 Q Okay. Well, let's look over to the --</p> <p>19 to page 4, or the fourth page of this. I don't</p> <p>20 believe it has page numbers.</p> <p>21 A Okay.</p> <p>22 Q About halfway through that paragraph it</p> <p>23 states, "Retest samples were reanalyzed using</p> <p>24 specific talc parameters on the XRF which should</p>	<p style="text-align: right;">Page 284</p> <p>1 I mean, it isn't gonna work.</p> <p>2 MR. FROST:</p> <p>3 Q Okay. You agree that's what the</p> <p>4 document says; right?</p> <p>5 A Yeah. You read it -- you read it the</p> <p>6 way it's written, but...</p> <p>7 Q All right. I'm gonna turn to some more</p> <p>8 general questions now.</p> <p>9 Now, you're generally aware that there</p> <p>10 are various regulations regarding ore reserve</p> <p>11 reporting, models of deposits, mine plans, things</p> <p>12 like that that miners have to abide by; correct?</p> <p>13 MS. O'DELL:</p> <p>14 Object --</p> <p>15 A You said regulations?</p> <p>16 MR. FROST:</p> <p>17 Q Yeah, regulations.</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 MR. FROST:</p> <p>21 Q Or laws and regulations.</p> <p>22 MS. O'DELL:</p> <p>23 Object to the form as vague as to time</p> <p>24 and location.</p>
<p style="text-align: right;">Page 283</p> <p>1 have been applied when the original samples were</p> <p>2 analyzed."</p> <p>3 A With XRF?</p> <p>4 Q XRF. I'm just reading from the</p> <p>5 document.</p> <p>6 A Uh-huh.</p> <p>7 Q "They were not applied because the</p> <p>8 analyst who typically runs the XRF was out of the</p> <p>9 office and her backup did not apply the</p> <p>10 talc-specific settings."</p> <p>11 Did I read that correctly?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form.</p> <p>14 A Yeah. I --</p> <p>15 MR. FROST:</p> <p>16 Q Do you agree with me that what they're</p> <p>17 saying there is that the first tested was because</p> <p>18 of poor lab procedure?</p> <p>19 MS. O'DELL:</p> <p>20 Object to the form.</p> <p>21 A I'm not sure that's what it says, but</p> <p>22 I'm -- and I'm puzzled about the use of XRF.</p> <p>23 I -- I would think that they would -- they had to</p> <p>24 have been XRD. You can't do XRF with asbestos.</p>	<p style="text-align: right;">Page 285</p> <p>1 A Yeah. The -- this -- you must be</p> <p>2 talking about state-specific things.</p> <p>3 MR. FROST:</p> <p>4 Q Let me -- the SEC, for example, has</p> <p>5 mining regulations. Are you aware of those?</p> <p>6 A Did you say SEC?</p> <p>7 Q I said SEC.</p> <p>8 A Like Southeastern Conference?</p> <p>9 Q No. Like the Securities Exchange</p> <p>10 Commission.</p> <p>11 A Yeah. I think that in the sense that</p> <p>12 if you're a publicly traded company, there's</p> <p>13 certain data that has to be made available.</p> <p>14 Q Okay. And there are also -- you know,</p> <p>15 there's also JORC? Have you ever heard of JORC,</p> <p>16 the Joint --</p> <p>17 A I've heard of it. I don't know what it</p> <p>18 is.</p> <p>19 Q Okay. And there's other bodies. EPA</p> <p>20 has regulations. State regulators have</p> <p>21 regulations. So you agree there's a body of law</p> <p>22 in regulation, right, that relates to mining?</p> <p>23 A There are --</p> <p>24 MS. O'DELL:</p>

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<p>1 Object to the form. Vague. It's 2 unclear what you're asking. 3 But if you understand the question -- 4 but don't speculate as to what it means. 5 A I -- I -- I think I understand it. 6 The states, when you're gonna open up a 7 mine, require certain information to be presented 8 in support of, really, your reclamation plan. 9 But in order to present a good reclamation plan, 10 you have to give them information about the 11 mining, the length of the mining operation, its 12 life, and some details about what you're doing. 13 So each state can have slightly varying 14 requirements for that. But the whole idea is 15 they want your money. They want you to put up a 16 reclamation bond. And in order to figure out 17 exactly how hard to squeeze, they need some 18 information. 19 MR. FROST: 20 Q Okay. I'll ask it a different way 21 because I'm not just focusing in on reclamation. 22 But are you aware that there are 23 regulations and standards out there that mines 24 have to follow regarding things like, you know,</p>	<p>1 would, you know, cover, for example, the Windsor 2 Minerals operations in Vermont? 3 A I don't see how it would be that 4 different from anything else, any other 5 operation. 6 Q Okay. But, sitting here today, can you 7 tell me that -- what the regulations are that 8 they're required to follow? 9 A Well -- 10 MS. O'DELL: 11 Object- -- objection as to 1965 to 12 2000 -- 13 MR. FROST: 14 Sure. I'm just asking generally if 15 he's aware of any of the -- the regulations that 16 are required, and then we can sort of focus in 17 from there. 18 MS. O'DELL: 19 Well, you asked a question that relates 20 to today at Windsor Minerals. And I don't think 21 Windsor Minerals is operating -- 22 MR. FROST: 23 It -- it doesn't -- 24 MS. O'DELL:</p>
Page 287	Page 289
<p>1 for example, model -- you know, how to model a -- 2 how -- how to model a deposit, mine plan, things 3 of that nature? 4 MS. O'DELL: 5 Object to the form. 6 A I have never been required to turn in a 7 mine plan to a regulatory agency. But what I 8 have had to turn in were the data necessary for 9 them to issue water permits and air permits. 10 And -- and those require some modeling. 11 I have an interest in three operating 12 mines right now. We've never been asked to 13 submit our detailed mining plans. 14 MR. FROST: 15 Q Okay. So you're getting very focused 16 in on -- on examples. So I guess is it fair to 17 say you're not an expert in nor are you 18 particularly familiar with, like, the JORC 19 specifications that require talc mines? 20 A Like I said, I've heard of JORC and 21 I -- but I don't know anything about it. 22 Q Okay. And you also couldn't tell me, 23 you know, other than a couple examples, you're 24 not an expert in the regulatory requirements that</p>	<p>1 -- in Virginia -- Virginia -- Vermont 2 today. 3 MR. FROST: 4 Q I'm not limiting my question today. 5 I'm just saying in general. 6 So I'll put it this way. I think we 7 established at the beginning you're not a 8 regulatory expert, nor do you hold yourself out 9 to be a regulatory expert. Correct? 10 MS. O'DELL: 11 Object to the form. 12 A I know a lot about it. 13 MR. FROST: 14 Q Okay. 15 A I don't know that I'm an expert. But 16 I've had to comply with regulatory rules and 17 regulations. And if I was going to go and get a 18 mine permit right now -- 19 Let's just use Alabama, because I know 20 enough about Alabama. 21 -- there's three permits required in 22 Alabama. There is an air permit. You've got to 23 prove that the operation that you're gonna open 24 up is not going to exceed a certain level of</p>

<p style="text-align: right;">Page 290</p> <p>1 particulate matter in the air, food, your 2 operation. 3 If you're gonna discharge water, you've 4 got to have a water permit. If you -- 5 You have to have what we call bugs and 6 bunnies study. You've got to prove there's no 7 endangered species. 8 You've got to have an anthropological 9 study that proves that you're not impacting a 10 site of, you know, Indians. 11 And then the final thing is you've got 12 to get a state mining permit. And in Alabama, 13 the state mining permit is virtually a rubber 14 stamp. It may not be in other states. But in 15 Alabama, that's -- that's what you've got to do. 16 And, I mean, I've done that three or four times 17 in the last ten years. 18 Q All right. 19 A And, so, I would assume -- I would 20 assume -- and, of course, there is -- once you 21 say you're gonna -- gonna operate, you need to 22 post your reclamation bond. And that then 23 requires you to present certain information. In 24 our -- in Alabama, it's to a State Department.</p>	<p style="text-align: right;">Page 292</p> <p>1 Q No. Its yearly ongoing operations. 2 A Yeah. Okay. This is all totally 3 different, then. Yeah. That's when MSHA gets 4 involved with you. 5 Q Okay. And MSHA's one, and there are 6 lots of regulatory agencies; correct? 7 A Yeah. Well, around here, MSHA's the 8 one that you fear. Because when they show up, 9 you're gonna get fined. I mean, they pay for 10 their visit here to your property. 11 And, so, there's a list of things that 12 they look at that's as long as your arm. And if 13 they can't find one of them out of compliance, 14 they'll generate one. 15 Q Okay. So other than the MSHA 16 requirements, which are health and safety, can 17 you tell me any of the other -- 18 You know, I've mentioned JORC. It 19 seems like you're not familiar with the JORC 20 requirements. Correct? 21 A If I am, it's under another name or 22 another agency applies their -- whatever their 23 regs are. 24 Q Okay. But, sitting here, you know, you</p>
<p style="text-align: right;">Page 291</p> <p>1 Q Okay. I'll ask it a different way. 2 Sitting here today, you can't tell me 3 what rules, laws, and regulations specifically 4 oversaw and that Windsor Myer -- Windsor Minerals 5 was required to abide by from the period of 1965 6 to the late 1990s when they were supplying talc 7 to Johnson & Johnson. Is that a fair statement? 8 A In the late 1990s, I think I gave you 9 some just now that they would have had to comply 10 with. 11 Q Okay. I'm not talking about some. I'm 12 talking about can you tell me the regulatory 13 requirements that Windsor Minerals would have 14 been required to follow with respect to their 15 mine and their mining practices? 16 MS. O'DELL: 17 Object to the form. 18 A Is this once the mine is in operation? 19 MR. FROST: 20 Q When the mine is operating. 21 A Oh, okay. I'm sorry. I thought you 22 were talking -- 23 Q No. I'm talking about -- 24 A -- about trying to open up the mine.</p>	<p style="text-align: right;">Page 293</p> <p>1 certainly can't say -- 2 For example, we don't need to go -- 3 A lot of the mine reports from -- from 4 the various miners talk about, you know, 5 complying with JORC specifications. You couldn't 6 tell me what those specifications -- 7 A What does JORC stand for? 8 Q Joint Ore Reserve Commission. 9 A No. 10 Q Okay. And you certainly don't list any 11 of the laws, regulations, and requirements within 12 your report, right, that -- 13 A No. 14 Q -- mining companies -- 15 A I bet you there's some mining companies 16 out west that would love to know about this. 17 Q Okay. But, again, focusing on your 18 report, you certainly don't list any of the laws, 19 regulations, requirements. 20 A No. 21 Q And you're not intending to offer any 22 opinions -- 23 A No. 24 Q -- about compliance with laws,</p>

<p style="text-align: right;">Page 294</p> <p>1 regulations, and requirements in this case.</p> <p>2 A No. But you're gonna make me go and</p> <p>3 look some stuff up.</p> <p>4 Q Sure.</p> <p>5 And would you agree with me that</p> <p>6 compliance with laws, requirements, regulations</p> <p>7 is one of the things --</p> <p>8 Strike that. I'll ask it differently.</p> <p>9 You talk quite a bit in your report</p> <p>10 about sampling methodologies. And do you agree</p> <p>11 with me there are probably thousands of papers</p> <p>12 that have been published about sampling</p> <p>13 methodologies, you know, how to determine whether</p> <p>14 or not a sample is representative of a greater</p> <p>15 group of ore and things like that; right?</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form.</p> <p>18 A I'm sure there's --</p> <p>19 Pardon me.</p> <p>20 I'm sure there -- I don't know that</p> <p>21 there's thousands, but I know there's a lot.</p> <p>22 MR. FROST:</p> <p>23 Q Okay. And there are a bunch of</p> <p>24 competing theories or different theories, anyway,</p>	<p style="text-align: right;">Page 296</p> <p>1 MS. O'DELL:</p> <p>2 Object to the form.</p> <p>3 A I have -- I have not. It's -- it's</p> <p>4 insufficient to -- to work with.</p> <p>5 MR. FROST:</p> <p>6 Q And, again, you know, you've -- you've</p> <p>7 run no analysis to determine --</p> <p>8 Well, we'll turn to the specifics when</p> <p>9 we get to them.</p> <p>10 But don't you agree that it's important</p> <p>11 as a scientist, when you're making a</p> <p>12 determination that something is complete or not,</p> <p>13 that it's based on the theories of peer-reviewed</p> <p>14 literature?</p> <p>15 MS. O'DELL:</p> <p>16 Object to the form.</p> <p>17 A Is complete or not?</p> <p>18 MR. FROST:</p> <p>19 Q Yes. Like here, such as -- you know,</p> <p>20 your overall opinion that the sampling, for</p> <p>21 example, done by the mining company is a</p> <p>22 representative. As a scientist, don't you agree</p> <p>23 with me that it's important to base those</p> <p>24 opinions on empirical data?</p>
<p style="text-align: right;">Page 295</p> <p>1 about how to do sampling, how to calculate,</p> <p>2 things of that nature; correct?</p> <p>3 A I don't know how competing they are. I</p> <p>4 know that they evolve with time. If you took a</p> <p>5 good paper that tried to hammer all this out that</p> <p>6 was published in 2015 and compared it to one that</p> <p>7 was written in 1985 --</p> <p>8 Q There'd be some differences.</p> <p>9 A Right. There might be competitive</p> <p>10 ideas in there.</p> <p>11 Q But you do agree with me sort of the</p> <p>12 underlying principle under most of the different</p> <p>13 theories is that you have to use geostatistics to</p> <p>14 determine whether or not what you're sampling is</p> <p>15 itself representative of the ore body; correct?</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form.</p> <p>18 A You -- yeah. You would hope that that</p> <p>19 would happen.</p> <p>20 MR. FROST:</p> <p>21 Q Okay. And am I also correct that you</p> <p>22 have not done any geostatistical analysis of any</p> <p>23 of the sampling data from either</p> <p>24 Johnson & Johnson or Imerys in this case?</p>	<p style="text-align: right;">Page 297</p> <p>1 MS. O'DELL:</p> <p>2 Object to the form.</p> <p>3 A It needs to be based on data. It sure</p> <p>4 does. I mean, and I think I've based my opinion</p> <p>5 on data and the lack thereof.</p> <p>6 MR. FROST:</p> <p>7 Q But you didn't run or attempt to run</p> <p>8 any type of statistical analysis to determine</p> <p>9 whether or not the sample was truly</p> <p>10 representative, the sample was --</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A No. And my point was that there's --</p> <p>14 there's -- they're missing -- there are intervals</p> <p>15 in time where there's missing data.</p> <p>16 MR. FROST:</p> <p>17 Q Okay.</p> <p>18 A When you have that, you can't do much.</p> <p>19 Q And you also agree with me, then, that</p> <p>20 your opinions regarding the adequacy of the</p> <p>21 sampling is based on an incomplete data set?</p> <p>22 MS. O'DELL:</p> <p>23 Object to the form.</p> <p>24 A It's -- it's worse than that. The</p>

<p style="text-align: right;">Page 298</p> <p>1 sampling mechanisms are not described. There'll 2 be a place where it'll describe or will mention 3 mechanical sampling, but it doesn't say when the 4 mechanical sampler was put in place to take the 5 place of, say, a grab sample. Doesn't say what 6 type of mechanical sampler it was. Is it 7 something that's sampling continuously or once an 8 hour an arm sweeps across a conveyor belt and 9 grabs a sample? There are all kind of samplers. 10 And when you've got some- -- something 11 as critical as -- as your cosmetic talc that 12 really requires, you know, careful attention, I 13 would like to have seen exactly where in the 14 various process this sampling was taking place. 15 And there -- there are references to 16 sampling at the mine itself, and we can't -- we 17 haven't seen the data. And yet there should be 18 hundreds and hundreds and hundreds of analyses of 19 drill hole cuttings that are being put in as 20 blast holes. You know, I'm sure that if you're 21 gonna do selective mining, you don't use a drill 22 hole spacing that's 10 feet on a -- on a side. 23 That's what we use in the quarry. And we get 24 huge amounts of rock.</p>	<p style="text-align: right;">Page 300</p> <p>1 well know. 2 A They have not suggested to me that 3 they've withheld anything. Whenever I've asked 4 for something, if they got it, they give it to 5 me. If they don't, I never see it. 6 MR. FROST: 7 Q But you're guessing that they're giving 8 you everything. You have no way of telling me 9 whether or not -- 10 A I don't know -- 11 Q -- they are -- 12 MS. O'DELL: 13 Excuse me. Are you finished with your 14 question? 15 MR. FROST: 16 Yeah. I'm finished. 17 MS. O'DELL: 18 Object to the form. 19 You may answer. 20 A I don't know that that's a guess. 21 MR. FROST: 22 Q Well, you certainly have done nothing 23 independently, nor have you been able to, to 24 verify that; correct?</p>
<p style="text-align: right;">Page 299</p> <p>1 If I was gonna be selectively mining 2 talc, I would have smaller faces, tighter holes. 3 I would be -- I wouldn't be having more than a 4 few thousand tons per blast. But I would know 5 exactly what I was fixing to blast and -- and 6 that data, there are documents to indicate that 7 the data sufficient to move in that direction 8 exists. But we never got it. 9 Q Okay. 10 A We've asked for it. 11 Q And that's -- that's very important. 12 Because one I think we've already established, 13 you have no way of telling whether or not you 14 actually have all the documents that are 15 relative -- are relevant to these points; 16 correct? 17 MS. O'DELL: 18 Object. 19 MR. FROST: 20 Q You have only what plaintiffs' counsel 21 has deemed to give you. 22 MS. O'DELL: 23 Object to the form. Based on what was 24 disclosed and produced in the litigation, as you</p>	<p style="text-align: right;">Page 301</p> <p>1 A I've tried to break into their offices 2 at night and see -- see if they had a big pile of 3 data they should have sent to me. 4 Q Well, did you ever ask if you could 5 have access to the full database -- 6 A I'm -- 7 Q -- of documents? 8 I'm not -- I know you're being 9 facetious. 10 A Yeah. 11 Q But have you ever asked to have full 12 access to the document database of the 13 documents -- 14 A If they're -- 15 Q -- provided by Johnson & Johnson and 16 Imerys? 17 MS. O'DELL: 18 Object. 19 A Pardon me. 20 No, certainly not, because of the 21 number involved. What would I do with 800,000 22 documents? 23 MR. FROST: 24 Q And you've never run any searches</p>

<p style="text-align: right;">Page 302</p> <p>1 yourself against the database?</p> <p>2 A No.</p> <p>3 Q So, again, you're just relying on what</p> <p>4 plaintiffs have given to you.</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A I have absolutely no reason to doubt</p> <p>8 the honesty of Miss O'Dell and company.</p> <p>9 MR. FROST:</p> <p>10 Q Well, I can tell you you don't have the</p> <p>11 complete copy -- complete compilation of all of</p> <p>12 the --</p> <p>13 A Well, one might ask why not since we've</p> <p>14 asked for them over and over again.</p> <p>15 Q I'm talking about the documents you</p> <p>16 have, sir. I can tell you there are testing</p> <p>17 results, for example, that aren't provided --</p> <p>18 A Well --</p> <p>19 MS. O'DELL:</p> <p>20 Object to --</p> <p>21 MR. FROST:</p> <p>22 Q We'll go over some of them later.</p> <p>23 MS. O'DELL:</p> <p>24 Object to the form.</p>	<p style="text-align: right;">Page 304</p> <p>1 MS. O'DELL:</p> <p>2 Objection to form.</p> <p>3 A I'm not saying that at all. I am not</p> <p>4 saying that. I'm saying that we have asked for</p> <p>5 all of the data. And if what I've been given is</p> <p>6 all you've got, then fine. That's fine with me.</p> <p>7 But I'm not saying that I've got -- that there's</p> <p>8 a data set out there that you guys have held back</p> <p>9 and not bothered to send in. I'm not gonna say</p> <p>10 that.</p> <p>11 MS. O'DELL:</p> <p>12 We've been going about an hour. Let's</p> <p>13 take a short break.</p> <p>14 MR. FROST:</p> <p>15 That's fine.</p> <p>16 VIDEOGRAPHER:</p> <p>17 Going off the record. The time is 2:44</p> <p>18 p.m.</p> <p>19 (OFF THE RECORD.)</p> <p>20 VIDEOGRAPHER:</p> <p>21 We're back on the record. The time is</p> <p>22 3:01 p.m.</p> <p>23 MR. FROST:</p> <p>24 Q I've sort of come up with another</p>
<p style="text-align: right;">Page 303</p> <p>1 MR. FROST:</p> <p>2 Q And we'll go over some of those later.</p> <p>3 But, again --</p> <p>4 So what we heard a lot of is you're not</p> <p>5 saying I've reviewed all the documents and I know</p> <p>6 they're not using the correct equipment. It</p> <p>7 sounds like your opinion more is "I can't tell</p> <p>8 what they're using and there's incomplete data</p> <p>9 here," and that's sort of the basis for your</p> <p>10 opinion. Is that -- is that a fair observation?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A Not -- not really. I mean, it's part</p> <p>14 of it. It's part of what I see, and the total</p> <p>15 document set that I've got is a suggestion that</p> <p>16 there's sampling going on. But even -- even if</p> <p>17 the sampling is taking place, we don't have</p> <p>18 analytical results for samples that should have</p> <p>19 been taken. And, so, it's very difficult to use</p> <p>20 anything other than what we've got to draw</p> <p>21 conclusions from.</p> <p>22 MR. FROST:</p> <p>23 Q Okay. You agree with me you're drawing</p> <p>24 conclusions based on an incomplete record.</p>	<p style="text-align: right;">Page 305</p> <p>1 general question I forgot to ask. But would you</p> <p>2 agree with me that compliance with legal</p> <p>3 standards is an important consideration in</p> <p>4 determining whether or not a mine is being</p> <p>5 properly operated?</p> <p>6 A Yes.</p> <p>7 Q All right. Turn to page 37 of your</p> <p>8 report.</p> <p>9 A Okay.</p> <p>10 Q Okay. The second full sentence on that</p> <p>11 page, it says, "Ore sampling techniques do not</p> <p>12 suggest representativeness and were questioned in</p> <p>13 a 2009 Intertek audit." And you cite Imerys</p> <p>14 031712.</p> <p>15 A I think that's with respect to Chinese</p> <p>16 talc.</p> <p>17 Q Okay.</p> <p>18 A Okay.</p> <p>19 Q Let's -- let's take a look at that</p> <p>20 document real quick.</p> <p>21 MS. O'DELL:</p> <p>22 031712?</p> <p>23 MR. FROST:</p> <p>24 031712, yes.</p>

<p style="text-align: right;">Page 306</p> <p>1 What number are we at?</p> <p>2 THE COURT REPORTER:</p> <p>3 27.</p> <p>4 (DEPOSITION EXHIBIT NUMBER 27</p> <p>5 WAS MARKED FOR IDENTIFICATION.)</p> <p>6 MR. FROST:</p> <p>7 Q I'll call your attention to page 5.</p> <p>8 A Okay.</p> <p>9 Q The first audit area, I take it that's</p> <p>10 what you're referencing --</p> <p>11 A Yes.</p> <p>12 Q -- in the sample.</p> <p>13 A Uh-huh.</p> <p>14 Q Okay. And, again, you'd agree with me</p> <p>15 that Intertek rates this audit area as minor;</p> <p>16 correct?</p> <p>17 A I'm looking for a level 5 on here. I'm</p> <p>18 not seeing -- I'm not seeing the level.</p> <p>19 Q It's under the box that goes audit</p> <p>20 area, finding, recommendation, and then rating.</p> <p>21 Is -- is the bottom.</p> <p>22 A Oh, the rating. I see it. Yeah.</p> <p>23 Q Then it says "minor."</p> <p>24 A Right. Right. Sure.</p>	<p style="text-align: right;">Page 308</p> <p>1 A That's true.</p> <p>2 Q Okay. We'll turn to 631362.</p> <p>3 (DEPOSITION EXHIBIT NUMBER 28</p> <p>4 WAS MARKED FOR IDENTIFICATION.)</p> <p>5 MR. FROST:</p> <p>6 Q And I'll direct your attention to page</p> <p>7 364, which is the callout from the report.</p> <p>8 MS. O'DELL:</p> <p>9 Bates number 364 at the end?</p> <p>10 MR. FROST:</p> <p>11 That's correct. So it's 631364.</p> <p>12 A Got it.</p> <p>13 MR. FROST:</p> <p>14 Q Okay. And if you look down at number</p> <p>15 14 --</p> <p>16 Well, first off, do you agree that this</p> <p>17 is a Certificate of Analysis from the mining</p> <p>18 company, the Chinese mining company?</p> <p>19 A Yes.</p> <p>20 Q Okay. And if you look down at 14, the</p> <p>21 document's been translated and it says: In the</p> <p>22 absence of asbestos, China SFDA method, none</p> <p>23 detected by X-Ray Diffraction, none detected as</p> <p>24 fibrous amphibole by Polarized Light Microscopy,</p>
<p style="text-align: right;">Page 307</p> <p>1 Q Okay.</p> <p>2 A Excuse me. I was looking for the</p> <p>3 letter -- the number 5.</p> <p>4 Q Oh. The number. Oh, okay. Sorry. It</p> <p>5 was page 5. I apologize if I caused confusion.</p> <p>6 A Well, 5 is the rating for minor.</p> <p>7 That's their minor rating.</p> <p>8 Q Oh, I see.</p> <p>9 So you'd agree with me that whatever</p> <p>10 concerns they may have addressed, they rated this</p> <p>11 as a minor concern?</p> <p>12 A To them?</p> <p>13 Q Yes.</p> <p>14 A Yes.</p> <p>15 Q Okay. Further down on page 37 of your</p> <p>16 report, next paragraph, sort of in the middle,</p> <p>17 you note that "As recently as 2016, Chinese</p> <p>18 testing for asbestos is implied in a Guilin</p> <p>19 Guiguang talc development company document,</p> <p>20 JNJ631362 at 364."</p> <p>21 And then, further down, the next</p> <p>22 sentence, you wrote, "I have not seen any data</p> <p>23 confirming this."</p> <p>24 Did I read that correctly?</p>	<p style="text-align: right;">Page 309</p> <p>1 performed only if detected by X-ray diffraction,</p> <p>2 et cetera.</p> <p>3 So do you agree with me that this is</p> <p>4 the mine owner certifying that they've tested the</p> <p>5 talc and it's come up as asbestos-free?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A It does not say that. It says they</p> <p>9 were unable to detect it with those techniques.</p> <p>10 And the limit of detection's like .1. So that's</p> <p>11 not what this says.</p> <p>12 MR. FROST:</p> <p>13 Q Well, it says "Absence of asbestos,</p> <p>14 none detected."</p> <p>15 Do you agree with me there?</p> <p>16 A That is -- that is the problem. They</p> <p>17 use this word "absence of asbestos" in their --</p> <p>18 their Certificates of Analyses, and yet the</p> <p>19 technique they're using can't justify that.</p> <p>20 Q So the reason you use the word</p> <p>21 "implied" is because they're using a nondetect</p> <p>22 standard as opposed to saying what? Non -- no</p> <p>23 asbestos?</p> <p>24 A Correct.</p>

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<p>1 Q But, again, they're testing it by, you</p> <p>2 know, China SFDA method; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A Their FDA method isn't necessarily</p> <p>6 consistent with what J&J would like.</p> <p>7 MR. FROST:</p> <p>8 Q Okay. But, again, we have testing</p> <p>9 here. They're doing it by x-ray diffraction, and</p> <p>10 then polarized light microscopy is what the --</p> <p>11 the notation says.</p> <p>12 A Right.</p> <p>13 Q Correct?</p> <p>14 A Correct.</p> <p>15 Q And you have no reason to doubt that --</p> <p>16 or to say that the Chinese mine owner is lying on</p> <p>17 their Certificate of Analysis; right?</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 A When he says "free from asbestos," he</p> <p>21 may be lying.</p> <p>22 MR. FROST:</p> <p>23 Q And why --</p> <p>24 A I mean, they do it all the time.</p>	<p>1 not gonna know.</p> <p>2 And, so, it's improper for them to say</p> <p>3 that there's no asbestos there. They should say</p> <p>4 no asbestos was detected. It's very simple.</p> <p>5 MR. FROST:</p> <p>6 Q Again, isn't that what they're saying,</p> <p>7 absence of asbestos showing the Chinese method</p> <p>8 and saying none detected?</p> <p>9 A No.</p> <p>10 Q I don't -- I don't understand. The</p> <p>11 words they're using on this paper are exactly</p> <p>12 what you're explaining to me.</p> <p>13 A No, they're not.</p> <p>14 Q I'm confused. All right. So it says</p> <p>15 absence of asbestos.</p> <p>16 A Stop.</p> <p>17 Q Right?</p> <p>18 A Stop right there. Absence of asbestos</p> <p>19 means there is none there. Correct?</p> <p>20 Q Well, that's -- under the test items,</p> <p>21 that's why --</p> <p>22 So if you look up, test items, it says,</p> <p>23 "Test, absence of asbestos." Right? Then it</p> <p>24 says, "Test method: China, SFDA method." And</p>
Page 311	Page 313
<p>1 Believe me. I mean, that's not unusual. But --</p> <p>2 but I'm not accusing them of lying. I'm saying</p> <p>3 that there is a confusion of terminology is all.</p> <p>4 Q Okay. And you believe the confusion of</p> <p>5 the terminology is that absence of asbestos, none</p> <p>6 detected --</p> <p>7 A They don't mean the same thing.</p> <p>8 Q -- implies --</p> <p>9 A They do not mean the same thing.</p> <p>10 Q Okay. And you don't believe that they</p> <p>11 are certifying here that, pursuant to the Chinese</p> <p>12 FSDA method, that this is, you know, certified as</p> <p>13 absent of asbestos?</p> <p>14 A If they're certi- --</p> <p>15 MS. O'DELL:</p> <p>16 Object to the form.</p> <p>17 A If they're certifying it as</p> <p>18 asbestos-free, then if I were Johnson & Johnson,</p> <p>19 I wouldn't -- I wouldn't be accepting that,</p> <p>20 because we've known all along that .1 is the</p> <p>21 lower detection limit using that -- that</p> <p>22 technique. So you could have .05 percent</p> <p>23 chrysotile in the sample, and their nondetect</p> <p>24 wouldn't ever say that. I mean, they just are</p>	<p>1 then, under acceptance of criteria, it says "none</p> <p>2 detected."</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A That does not mean absence. I mean,</p> <p>6 the two do not mean the same thing. That's --</p> <p>7 that's my point.</p> <p>8 MR. FROST:</p> <p>9 Q So --</p> <p>10 A When you --</p> <p>11 Listen, this isn't that difficult.</p> <p>12 When you say that you can't detect something, it</p> <p>13 doesn't mean it isn't there. It may be there but</p> <p>14 in a level lower than your detection limit. So</p> <p>15 when they're using those two techniques, there is</p> <p>16 a lower detection limit that -- that is really</p> <p>17 inadequate, I think, for Johnson & Johnson's</p> <p>18 purposes. Because you can't say that something</p> <p>19 is absent if you can only detect down to a tenth</p> <p>20 of a percent. And that's what's going on here.</p> <p>21 Q Okay. And that's --</p> <p>22 A This is very simple.</p> <p>23 Q And that's just your opinion; right?</p> <p>24 A No. No. That's not my opinion, no,</p>

<p style="text-align: right;">Page 314</p> <p>1 sir.</p> <p>2 Q Let me ask my question. That's just</p> <p>3 your opinion, but we've already established the</p> <p>4 FDA J4-1 method that they're required to test</p> <p>5 requires XRD; correct?</p> <p>6 A Absolutely.</p> <p>7 Q And we've already established that</p> <p>8 you're not an expert and can sit here and say</p> <p>9 that asbestos below a level of .1 percent is</p> <p>10 capable of causing human disease; correct?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A Human disease I'm not an expert in.</p> <p>14 MR. FROST:</p> <p>15 Q Yeah. Exactly.</p> <p>16 A So that has nothing to do with this.</p> <p>17 Q And, again, they're saying free --</p> <p>18 they're not saying there's no asbestos in here.</p> <p>19 They're saying --</p> <p>20 A Yes, they are.</p> <p>21 Q No.</p> <p>22 A They say an absence of asbestos.</p> <p>23 Q That's the test name, if you look at</p> <p>24 the column. They're saying none detected.</p>	<p style="text-align: right;">Page 316</p> <p>1 Q That's the test. You agree with me</p> <p>2 that's the test, and then the results are</p> <p>3 truthfully reporting as you're requiring, because</p> <p>4 it says "none detected."</p> <p>5 A Correct.</p> <p>6 MS. O'DELL:</p> <p>7 Objection. Objection to form.</p> <p>8 Just give me a moment.</p> <p>9 MR. FROST:</p> <p>10 Q And, again, and you're saying that this</p> <p>11 is only an implication that there's not asbestos</p> <p>12 in this product because you disagree completely</p> <p>13 with the --</p> <p>14 A I'm not --</p> <p>15 Q -- required testing method.</p> <p>16 MS. O'DELL:</p> <p>17 Let him finish, please.</p> <p>18 THE WITNESS:</p> <p>19 Sure. I'm sorry.</p> <p>20 MS. O'DELL:</p> <p>21 And then let me do the object- --</p> <p>22 Object to the form.</p> <p>23 A I don't think that there's an</p> <p>24 implication here at all. I think that this is</p>
<p style="text-align: right;">Page 315</p> <p>1 A If they say "none detected," that's</p> <p>2 fine.</p> <p>3 Q And that's -- isn't that exactly what</p> <p>4 it says here?</p> <p>5 A It doesn't mean asbestos-free. So if</p> <p>6 they're putting this in the asbestos-free column</p> <p>7 and they're using that statement to show that</p> <p>8 it's asbestos-free, that's not right.</p> <p>9 Q So, again, where in this document does</p> <p>10 it say asbestos-free?</p> <p>11 A I thought that you said that's what the</p> <p>12 column was labeled.</p> <p>13 Q The test is absence of asbestos.</p> <p>14 A That's asbestos-free.</p> <p>15 Q And the -- no. It says absence of</p> <p>16 asbestos. You are changing the words. Look at</p> <p>17 the document.</p> <p>18 MS. O'DELL:</p> <p>19 Object to the form.</p> <p>20 MR. FROST:</p> <p>21 Q It says absence of asbestos.</p> <p>22 A I'm not changing the words.</p> <p>23 Q Well, where does it say asbestos-free?</p> <p>24 A Isn't "absence of" mean free of?</p>	<p style="text-align: right;">Page 317</p> <p>1 the crux of a large issue, and that is that J&J</p> <p>2 would like for their talc product to be</p> <p>3 asbestos-free. And that's great.</p> <p>4 But to say something is not detected</p> <p>5 when your lower detection limit is actually quite</p> <p>6 high, that doesn't show that something is absent</p> <p>7 from your product. It doesn't show that it's</p> <p>8 asbestos-free.</p> <p>9 And "absent of" and "free of," if</p> <p>10 you -- I mean, we can get out Webster's</p> <p>11 dictionary if you want to and argue this. But I</p> <p>12 would say that -- that most people would say that</p> <p>13 those two things mean the same.</p> <p>14 MR. FROST:</p> <p>15 Q Okay. And, again, you'd agree with me</p> <p>16 that Johnson & Johnson requires that a particular</p> <p>17 test be run on its talc; correct?</p> <p>18 A I think so.</p> <p>19 MS. O'DELL:</p> <p>20 Object to the form.</p> <p>21 MR. FROST:</p> <p>22 Q Okay. And --</p> <p>23 MS. O'DELL:</p> <p>24 As to asbestos or as to what?</p>

<p style="text-align: right;">Page 318</p> <p>1 MR. FROST:</p> <p>2 As to asbestos. Talking about</p> <p>3 asbestos.</p> <p>4 MS. O'DELL:</p> <p>5 Over time or --</p> <p>6 MR. FROST:</p> <p>7 We're talking -- you know, right now</p> <p>8 we're talking J4-1, right, that testing method,</p> <p>9 the XRD testing method.</p> <p>10 Q You agree that that's the testing</p> <p>11 method that Johnson & Johnson and Imerys used;</p> <p>12 correct?</p> <p>13 A That's right.</p> <p>14 Q You also agree that that's the method</p> <p>15 that the FDA, you know, requires that talcum</p> <p>16 powder be tested for asbestos; correct?</p> <p>17 MS. O'DELL:</p> <p>18 Object to the form.</p> <p>19 A I agree with all of that --</p> <p>20 MR. FROST:</p> <p>21 Q Yeah. That's what I'm saying.</p> <p>22 A -- except that that doesn't prove that</p> <p>23 a product is free of asbestos. It only proves</p> <p>24 that --</p>	<p style="text-align: right;">Page 320</p> <p>1 problem.</p> <p>2 Q Okay. Don't you agree with me that</p> <p>3 every method of testing has a lower limit of</p> <p>4 detection?</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A That's -- that's tough. But I think,</p> <p>8 in general, that's probably a pretty good</p> <p>9 statement.</p> <p>10 MR. FROST:</p> <p>11 Q Okay.</p> <p>12 A I think the day is gonna come when --</p> <p>13 when there will be equipment that's good enough</p> <p>14 to say, you know, under any circumstances,</p> <p>15 there's none there.</p> <p>16 Q Okay.</p> <p>17 A But I don't think we're quite there</p> <p>18 yet.</p> <p>19 Q Okay. And, going to your scenario, if</p> <p>20 you told your student to go test that sample</p> <p>21 using XRD --</p> <p>22 A Right.</p> <p>23 Q -- and he tested it and came back and</p> <p>24 said no asbestos --</p>
<p style="text-align: right;">Page 319</p> <p>1 Q I'm not asking that, sir.</p> <p>2 A Well, but that's what it said over and</p> <p>3 over again in the COAs is "free of." And they</p> <p>4 need to say it's free of down to a detection</p> <p>5 level of .1 percent.</p> <p>6 Q So your opinion is you just don't like</p> <p>7 the terminology they're using, but you have no</p> <p>8 opinion that anything below a .1 would cause</p> <p>9 disease or be dangerous to human health?</p> <p>10 MS. O'DELL:</p> <p>11 Object to the form.</p> <p>12 A No. You keep adding human health in</p> <p>13 there. I'm not -- I'm not trying to opine about</p> <p>14 human health. I'm just saying that if I had a</p> <p>15 student and I handed him a sample and I said "Is</p> <p>16 there any asbestos in this or not," and he goes</p> <p>17 to the x-ray machine and comes back and says,</p> <p>18 "No, I couldn't find any by x-ray," I'll probably</p> <p>19 give him an F.</p> <p>20 Q Okay.</p> <p>21 A Because it doesn't mean that there's no</p> <p>22 asbestos in that sample. It means that he</p> <p>23 couldn't detect it down to the lower detection</p> <p>24 limit of that machine. And -- and therein is a</p>	<p style="text-align: right;">Page 321</p> <p>1 A Right.</p> <p>2 Q -- you wouldn't fail him for that</p> <p>3 because he was following the test; correct?</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 A No. I would. He should come back and</p> <p>7 say, "Why did you tell me to go to the x-ray</p> <p>8 machine to do this?"</p> <p>9 MR. FROST:</p> <p>10 Q So even though you told him to go --</p> <p>11 A Yeah.</p> <p>12 Q So if you told somebody to go test</p> <p>13 something using this test method, you would still</p> <p>14 fail them when they came back and said "I used</p> <p>15 the test method you told me and it" --</p> <p>16 A Well, it depends on what he comes back</p> <p>17 with. If he comes back and says, you know, "I</p> <p>18 know that there's a lower limit on the ability of</p> <p>19 this equipment to detect asbestos and, based on</p> <p>20 that, I can't find any in here," he gets an A.</p> <p>21 That's an A.</p> <p>22 If he comes back and he says, "Oh, I</p> <p>23 went up there and kicked the machine two or three</p> <p>24 times, you know, it wouldn't spit out an asbestos</p>

<p style="text-align: right;">Page 322</p> <p>1 determination, so I don't think there is any,"</p> <p>2 well, I'd be irritated. That's not -- you know,</p> <p>3 that's not a good -- a good answer to come back</p> <p>4 to the teacher.</p> <p>5 Q Okay. And you'd agree with me that the</p> <p>6 FDA knows that .1 percent is the lower detection</p> <p>7 limit on XRD? I mean, everybody sort of knows</p> <p>8 that.</p> <p>9 A I think so, sure.</p> <p>10 Q Okay. And still that's the test method</p> <p>11 that they've required; correct?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form. Misstates the law.</p> <p>14 A As far as I know today, it -- it is. I</p> <p>15 know that there are modifications being</p> <p>16 considered for sure.</p> <p>17 MR. FROST:</p> <p>18 Q Okay. But, as of today, you agree with</p> <p>19 me that that's --</p> <p>20 A I think so.</p> <p>21 MS. O'DELL:</p> <p>22 Object to the form.</p> <p>23 MR. FROST:</p> <p>24 Q Turn to page 37. Which I think we were</p>	<p style="text-align: right;">Page 324</p> <p>1 types 30 and 40) and talc/carbonate schist (ore</p> <p>2 types 10 and 20.)"</p> <p>3 A Right.</p> <p>4 Q Okay. You agree with me that nowhere</p> <p>5 in here are they talking about ore type 66 which</p> <p>6 was used in Johnson & Johnson in its talcum</p> <p>7 powder?</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A They don't mention it.</p> <p>11 MR. FROST:</p> <p>12 Q Okay. And, then, also on page 2, if</p> <p>13 you look down to the next paragraph, second</p> <p>14 sentence states, "Blast holes are analyzed for</p> <p>15 brightness, talc, and arsenic content and the</p> <p>16 presence of amphiboles."</p> <p>17 MS. O'DELL:</p> <p>18 Where are you reading, Jack?</p> <p>19 MR. FROST:</p> <p>20 It's third paragraph, second sentence.</p> <p>21 MS. O'DELL:</p> <p>22 Okay. Thank you.</p> <p>23 MR. FROST:</p> <p>24 Q Did I read that correctly?</p>
<p style="text-align: right;">Page 323</p> <p>1 on page 37, weren't we?</p> <p>2 A Yeah.</p> <p>3 Q So I'm gonna turn to the bottom</p> <p>4 paragraph.</p> <p>5 A Okay.</p> <p>6 Q The second sentence starts:</p> <p>7 "Production drill data do not seem to include</p> <p>8 asbestos (chrysotile or amphibole) testing, and</p> <p>9 in relation to drill cores taken from the Hamm</p> <p>10 mine, for example, Imerys did not sample talc ore</p> <p>11 intervals containing visible fibrous amphibole."</p> <p>12 Then you say Imerys 238270.</p> <p>13 Did I read that correctly?</p> <p>14 A I think you did.</p> <p>15 Q Let's look at 238270.</p> <p>16 (DEPOSITION EXHIBIT NUMBER 29</p> <p>17 WAS MARKED FOR IDENTIFICATION.)</p> <p>18 MR. FROST:</p> <p>19 Q Do you recognize this document?</p> <p>20 A I do.</p> <p>21 Q First I'll call your attention to the</p> <p>22 second paragraph on page 2. And it states,</p> <p>23 quote, "Generally speaking, there are two types</p> <p>24 of Hamm ore: Massive talc/carbonate "grit" (ore</p>	<p style="text-align: right;">Page 325</p> <p>1 A Right.</p> <p>2 Q Okay. You'd agree with me that drill</p> <p>3 holes are production drill data; correct? That</p> <p>4 blast holes are part of the production drill data</p> <p>5 a mine would produce?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A If you use them as such, yes. There --</p> <p>9 there are plenty of companies that don't use them</p> <p>10 other than just for blast holes.</p> <p>11 MR. FROST:</p> <p>12 Q Okay. But here it seems like they are,</p> <p>13 because it says they're testing it.</p> <p>14 A Yes, correct. And that's -- you know,</p> <p>15 that's one of the reasons I cited this.</p> <p>16 Q Okay. But, again, like you said, they</p> <p>17 do not seem to include asbestos, chrysotile, or</p> <p>18 amphibole. Don't they say directly here that</p> <p>19 they're testing for the presence of amphibole?</p> <p>20 A They do.</p> <p>21 Q Okay.</p> <p>22 A My issue was we didn't have any test</p> <p>23 results for amphibole.</p> <p>24 Q Okay. But, again, this document -- you</p>

<p style="text-align: right;">Page 326</p> <p>1 know, the statement you attribute to this 2 document is that production drill data does not 3 seem to include asbestos, but it shows here 4 they're specifically testing for it; correct? 5 MS. O'DELL: 6 Object to the form. That's not what 7 his statement is in his report. 8 MR. FROST: 9 Q Okay. Well, I thought I read it 10 correctly. 11 I'll also turn your attention to page 12 4. 13 A Okay. 14 Q And the last sentence says, "Talc ore 15 observed to contain fibrous amphibole was not 16 included in a sample interval." 17 And that's what you note in your 18 report; correct? 19 A Right. 20 Q Okay. 21 A Yeah, that would -- that -- I can't 22 understand why they wouldn't have pulled it out, 23 looked at it to see if it is truly asbestos or 24 not.</p>	<p style="text-align: right;">Page 328</p> <p>1 A No, no. They're rejecting the analysis 2 of it. They don't say they're rejecting the -- 3 the ore. I mean, that -- that would be a 4 completely different thing. 5 If I -- if I was drilling at, say, Hamm 6 and pulled out a piece of drill core that had a 7 foot of cross-fiber asbestos in it, I'd sure want 8 to know everything about it, where it was, where 9 it went, is it truly asbestos, what's the 10 mineralogy, what's it associated with. I 11 wouldn't remove it from the core and throw it 12 away. 13 Q So, based on this one single sentence 14 in this one document, you are assuming that 15 because they're not testing what they already 16 have identified as fibrous amphiboles, that 17 they're including it in the ore? 18 MS. O'DELL: 19 Object to form. 20 A No, no. I didn't say that at all. 21 MR. FROST: 22 Q But -- so the whole point of testing's 23 to figure out where, for example, asbestos would 24 be and where it wouldn't be in the deposit;</p>
<p style="text-align: right;">Page 327</p> <p>1 Q Well, that -- that kind of becomes my 2 question. 3 Sorry. I didn't mean to interrupt him. 4 If you're not done -- sorry. 5 MS. O'DELL: 6 You may finish. 7 A Yeah. That was one of the reasons that 8 I mentioned this. And there -- there are other 9 places where it's pretty clear that they -- they 10 actually rejected core from analysis, and yet 11 they mention amphiboles. And it was like, "Okay. 12 There's some amphibole. We're not analyzing this 13 stuff." You got that feeling from looking at 14 some of this material. 15 MR. FROST: 16 Q Well, what would be the purpose of 17 testing something you already know contains 18 fibrous amphibole? Don't they already know 19 there's asbestos in that? 20 A To determine whether or not it really 21 is asbestos. 22 Q Well, if they're rejecting it because 23 it has fibrous amphibole, who cares if it is 24 actually --</p>	<p style="text-align: right;">Page 329</p> <p>1 correct? 2 A It's -- it's that and to determine 3 the -- the characteristics of the fibrous 4 amphibole. 5 Q And, again, if you're trying to come up 6 with a mine plan, you're trying to figure out 7 where you should take ore from and where you 8 shouldn't. Correct? 9 A Correct. And this is -- I mean, this 10 is part of my point. I mean, what happens if the 11 geologist that logged this core leaves and takes 12 another job and you hire somebody else? He has 13 to come in and pick up where the other guy left 14 off, and he's charged with helping to devise the 15 mine plan, and that interval's gone. 16 Q Let me -- that's a great question, too. 17 A I mean -- 18 Q No, no. Hold on. 19 Where in the sentence does it say 20 they've left it out of the mine plan? 21 A The mine plan isn't -- isn't mentioned 22 here. I'm just using that as an example of 23 how -- 24 Q Well, I was gonna say --</p>

<p style="text-align: right;">Page 330</p> <p>1 A -- this could be very, very bad.</p> <p>2 MS. O'DELL:</p> <p>3 Let him finish.</p> <p>4 MR. FROST:</p> <p>5 Q So you're speculating that because they</p> <p>6 weren't specifically testing something they've</p> <p>7 already identified as asbestos, that they're</p> <p>8 leaving it out of the mine plan?</p> <p>9 A Did they call that asbestos?</p> <p>10 Q They called it fibrous amphibole.</p> <p>11 A Right.</p> <p>12 Q So --</p> <p>13 But you're saying the whole theory is</p> <p>14 that somebody might come later and might not know</p> <p>15 what it is. But that means that this wasn't</p> <p>16 included on a mine plan.</p> <p>17 A That's not what I said.</p> <p>18 Q So you're drawing a --</p> <p>19 No, no?</p> <p>20 You're drawing a lot of conclusions</p> <p>21 that aren't supported by this document. Do you</p> <p>22 agree with me?</p> <p>23 A That is not --</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 332</p> <p>1 A The concern is that they didn't pull it</p> <p>2 out and test it. And there are other -- there</p> <p>3 are other statements, maybe not in this</p> <p>4 particular document, where they actually talk</p> <p>5 about removing the intervals and throwing them</p> <p>6 away.</p> <p>7 Q Okay. So, again, your whole basis is</p> <p>8 they've identified it's asbestos, but they</p> <p>9 haven't tested to see exactly what type of</p> <p>10 asbestos it is?</p> <p>11 A Fibrous amphibole.</p> <p>12 MS. O'DELL:</p> <p>13 Excuse me.</p> <p>14 MR. FROST:</p> <p>15 Q Okay.</p> <p>16 MS. O'DELL:</p> <p>17 Excuse me. Just let me object.</p> <p>18 MR. FROST:</p> <p>19 Okay.</p> <p>20 MS. O'DELL:</p> <p>21 Give me a minute.</p> <p>22 THE WITNESS:</p> <p>23 Sure.</p> <p>24 MS. O'DELL:</p>
<p style="text-align: right;">Page 331</p> <p>1 Excuse me.</p> <p>2 A That is not what I said.</p> <p>3 MR. FROST:</p> <p>4 Q Okay. Let's turn to page --</p> <p>5 A I did not say that.</p> <p>6 MS. O'DELL:</p> <p>7 He's not finished yet.</p> <p>8 A This is very simple. When you're</p> <p>9 logging drill core, if you see something that's</p> <p>10 suspect, you don't ignore it. You pull it out,</p> <p>11 you test it, you make notes about it, and, if</p> <p>12 you're having to use it in a mine plan, you make</p> <p>13 damn sure that the people that come behind you</p> <p>14 know that you saw fibrous amphibole at this step</p> <p>15 in this particular drill hole.</p> <p>16 MR. FROST:</p> <p>17 Q And where does it say they're not</p> <p>18 logging it? That's my confusion.</p> <p>19 A No, no. They have it --</p> <p>20 Q Where in this sentence does it say</p> <p>21 they're not logging it?</p> <p>22 A I'm not saying that they didn't log it.</p> <p>23 Q But you're saying that's the whole</p> <p>24 concern.</p>	<p style="text-align: right;">Page 333</p> <p>1 Don't interrupt him.</p> <p>2 MR. FROST:</p> <p>3 Q Okay. Can you turn to page 1, please.</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 Have you finished your answer, Doctor?</p> <p>7 If you have, fine.</p> <p>8 MR. FROST:</p> <p>9 Yeah. I was actually in the middle of</p> <p>10 a question. You interrupted me, Leigh.</p> <p>11 Q So can we turn back to page 1, please?</p> <p>12 MS. O'DELL:</p> <p>13 My apologies. It's hard to tell</p> <p>14 because --</p> <p>15 MR. FROST:</p> <p>16 That's okay.</p> <p>17 MS. O'DELL:</p> <p>18 -- you keep getting cut off.</p> <p>19 So what's your question?</p> <p>20 MR. FROST:</p> <p>21 Q Turning to page 1, second paragraph</p> <p>22 down, it says, quote, "Fibrous amphiboles</p> <p>23 (actinolite) were observed only within</p> <p>24 chloritized mafic dikes, extending, in places, a</p>

<p style="text-align: right;">Page 334</p> <p>1 couple of inches into the contacting talc ore." 2 So they certainly documented where it 3 was they found the fibrous amphiboles. 4 A Sure. 5 Q And they've identified what type of 6 fibrous amphibole it is. So it's clearly part of 7 the mine knowledge. They've identified that it's 8 actinolite and that it's fibrous, and they've 9 also identified that it only extends a couple 10 inches into the ore body. Is that correct? 11 A That's correct. 12 Q And you also -- you note somewhere else 13 in your report in the beginning that, as a rule 14 of thumb, they used, you know, exclusion zones. 15 And that's -- 16 A Selective mining. 17 Q Yeah. 18 So, again, if they know where it is, 19 they know how far it extends into the dike and 20 it's -- they're using exclusion zone, don't they 21 know where this fibrous amphibole is and aren't 22 they avoiding it? 23 MS. O'DELL: 24 Object to the form.</p>	<p style="text-align: right;">Page 336</p> <p>1 information. 2 A No. If there was only one drill hole 3 and if the ore deposit was bounded by a flat 4 plane or surface and you have a drill hole that 5 goes through it and you know that the ore body 6 margin is a flat plane, then you can design 7 your -- your -- your -- your mine to stay away 8 from that one point. 9 The problem with this is that the ore 10 bodies are irregular in shape. So you have a 11 drill hole. Yep, we found a little bit of 12 asbestos, but you don't know five feet away 13 whether or not you've got asbestos. You don't 14 know whether it will be a foot thick or 15 millimeter thick or if it's gonna be there at 16 all. 17 Q Okay. But, again, that's, one, 18 different than what you said here in the report, 19 but, two, what I'm getting at, isn't interpreting 20 the drill holes and interpreting, you know, 21 what's coming in and out of the mine what the 22 mine engineer does? Isn't what they 23 extrapolate -- extrapolate based on their 24 experience within the ore and they extrapolate</p>
<p style="text-align: right;">Page 335</p> <p>1 A In that one point where that one drill 2 hole goes through the zone that has fibrous 3 amphibole, we're gonna assume it's asbestos. 4 But you're looking really at a 5 one-dimensional point in a three-dimensional 6 space. So how do you design your mine around 7 that point? 8 I mean, if -- if the ore body was 9 bounded by absolutely vertical straight walls 10 that extend in all directions to infinity, then 11 that one drill hole is really all you need, and 12 you -- you can design a mine around that one 13 hole. 14 But that's not -- that's not the shape, 15 size of the ore bodies out here. 16 MR. FROST: 17 Q Okay. You're confusing me again. 18 Where does it say that it's only one ore sample 19 they ever found fibrous amphibole in? 20 A I didn't say that. 21 Q Well, that's what your answer you just 22 gave me implied, that -- 23 A No. I said -- 24 Q -- it -- that they wouldn't have</p>	<p style="text-align: right;">Page 337</p> <p>1 based on their production drill holes, based on 2 the exploratory drill holes, what they expect the 3 talc body to look like? 4 A Absolutely. 5 MS. O'DELL: 6 Object to -- 7 Excuse me. I object to the form of the 8 question. I object to the commentary. Misstates 9 the report. 10 MR. FROST: 11 I don't believe there was any 12 commentary, but -- 13 MS. O'DELL: 14 There was commentary leading up. 15 A I understand your question. The -- the 16 mining superintendent, which at Argonaut was one 17 of my former students for four years, they are 18 charged with taking all the data that we're 19 talking about and designing a mine plan that 20 insures that J&J is not gonna receive a product 21 coming out of the West Windsor mill that's got 22 asbestos in it. And that -- that is a very -- 23 that's a tough order. I mean, you've got to be 24 on your toes and --</p>

<p style="text-align: right;">Page 338</p> <p>1 And, in my experience, it's not -- it's 2 not a good idea to -- to ignore something that 3 you see in drill core that may be deleterious 4 without -- without testing it, maybe even 5 drilling a second hole. 6 There's a process known as hole 7 twinning, and a person might have wanted to -- 8 it's almost like the duplicate analysis. It 9 doesn't find anything the second time. Sometimes 10 you drill a second hole five feet away and 11 there's nothing there. Hey, good. 12 MR. FROST: 13 Q So this is why I'm confused. I mean, 14 again, this document doesn't talk about twinning. 15 It doesn't talk about --- 16 A No, no. 17 Q They may have been doing all these 18 things. You're talking now in sort of 19 generalities as far as mining goes. 20 A I'm trying to be as specific as I can. 21 MS. O'DELL: 22 Object to the form. 23 MR. FROST: 24 Q But what I'm saying is --</p>	<p style="text-align: right;">Page 340</p> <p>1 that all fibrous amphibole is asbestos? It's 2 fine with me if we do. 3 MR. FROST: 4 Q Well, they called it here fibrous 5 amphibole actinolite. 6 A I know. They don't use the word 7 "asbestos." 8 Q Okay. 9 A Okay. So -- so let's call it asbestos. 10 To know whether or not something's actinolite, 11 you've got to know the chemistry, and you can't 12 do that by logging drill core. 13 If it's -- if it's a green fibrous 14 amphibole, then if I was logging it, I'd assume 15 it was actinolite. Okay. Go with it. I -- 16 The point of all this is that -- 17 that -- that a fibrous amphibole in a drill hole, 18 even if it's at the ore body margin, is an 19 important thing. 20 Q Okay. 21 A And I would have done more than just -- 22 than just pass it off, which is the feeling that 23 I got when I read that, that they didn't do 24 anything with it but record it. So, okay.</p>
<p style="text-align: right;">Page 339</p> <p>1 Let's see. What do we have here? 2 So you have, "Imerys did not sample 3 talc ore intervals containing visible fibrous 4 amphiboles. This is contrary to all accepted 5 sampling practices." 6 But, again, if they know that this 7 particular section of the drill core contained 8 asbestos, we know they've identified where it is 9 on the mine plan because they say that on, one, 10 fibrous amphibole was observed only within the 11 chloritized mafic dikes, extending in places a 12 couple inches into the containing [sic] talc ore. 13 We know they've already identified it as 14 actinolite asbestos. 15 A Well, they describe -- 16 Q What are they leaving out of the 17 analysis? Just that they're confirming that what 18 they believe is fibrous amphibole actinolite 19 actually is fibrous amphibole actinolite? 20 MS. O'DELL: 21 Object to the form. Misstates the 22 document. 23 A Well, to start with, they call it 24 fibrous amphibole. Okay? Are we gonna assume</p>	<p style="text-align: right;">Page 341</p> <p>1 Q And can you give me -- 2 Because you say here, you know, that 3 this is contrary to all accepted sampling 4 practices. 5 A Yes. 6 Q What are you relying on for that? What 7 published literature, what regulation, what law? 8 A There's -- 9 Oh, this isn't a legal issue at all. 10 But if you -- 11 There are many books that have been 12 written about the evaluation and sampling of a 13 mine. And when you -- when you hit a critical 14 interval, if it's a channel sample underground 15 that you're cutting with your rock hammer, if 16 you're digging a trench at the surface, if you're 17 drilling a drill hole, when -- when you -- when 18 you hit something that's significant relative to 19 the commodity you're looking at, you normally do 20 more with it than just make a note, "Oh, there it 21 is," and move on. 22 Q Okay. And what from this document 23 implicates to you that they just moved on from it 24 and they didn't put it in the mine plan?</p>

<p style="text-align: right;">Page 342</p> <p>1 A We have no mine plan.</p> <p>2 Q So --</p> <p>3 A We've asked for the mine plan.</p> <p>4 Q So you're basing everything off the</p> <p>5 fact that you haven't seen a mine plan? So</p> <p>6 you've read that in conjunction with this</p> <p>7 document to say that they are just ignoring the</p> <p>8 fibrous amphibole that they're finding and moving</p> <p>9 on, which is contrary to standard --</p> <p>10 MS. O'DELL:</p> <p>11 Excuse me --</p> <p>12 A That's absolutely not what I said.</p> <p>13 MS. O'DELL:</p> <p>14 Excuse me. Object to the form.</p> <p>15 A Did not say that.</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form. Misstates his</p> <p>18 testimony.</p> <p>19 A Really. I didn't say that.</p> <p>20 MR. FROST:</p> <p>21 Q So, again, what -- what is it that</p> <p>22 they're doing here that is contrary to standard?</p> <p>23 Is it purely that they're not testing to see</p> <p>24 exactly what the fibrous actinolite or the --</p>	<p style="text-align: right;">Page 344</p> <p>1 And a lot of times you blame that on</p> <p>2 the driller, but -- but it may simply be because</p> <p>3 of a characteristic of the rock itself.</p> <p>4 And, so, there -- when you -- when you</p> <p>5 look at all the drill core data, what you find is</p> <p>6 that there -- there are drill holes that -- that</p> <p>7 we have missing -- we have missing core, and it's</p> <p>8 not the fault of anybody. Probably it's just the</p> <p>9 rock.</p> <p>10 Then we have areas where there's</p> <p>11 actually notations that the drill core has been</p> <p>12 discarded, removed from the core box, and thrown</p> <p>13 away. And that's suspicious.</p> <p>14 Q Okay.</p> <p>15 A And that's, you know, part of the big</p> <p>16 picture here.</p> <p>17 Q But, again, the only document you're</p> <p>18 showing for reliance to the statement that this</p> <p>19 is contrary to all accepted sampling practices is</p> <p>20 Imerys 238270, which shows that they have</p> <p>21 identified there's a potential problem in the</p> <p>22 body. They've also identified where it is, and</p> <p>23 they've identified that they're avoiding it;</p> <p>24 correct?</p>
<p style="text-align: right;">Page 343</p> <p>1 What do they call it?</p> <p>2 -- fibrous amphibole actinolite is? Is</p> <p>3 that -- is that your --</p> <p>4 Your main gripe is that they haven't</p> <p>5 confirmed whether or not it's asbestiform or not</p> <p>6 asbestiform?</p> <p>7 A That would be --</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A That would be a complaint.</p> <p>11 MR. FROST:</p> <p>12 Q Okay.</p> <p>13 A But -- but this is part of a larger</p> <p>14 picture. You know, as I mentioned, I think that</p> <p>15 there -- there are other instances where the</p> <p>16 logging of drill core ended up with a couple of</p> <p>17 issues, one. And this is typical of diamond</p> <p>18 drilling. You don't have a hundred percent core</p> <p>19 recovery anyway.</p> <p>20 And, so, it's difficult to make mine</p> <p>21 plans when you've got -- when you're pulling core</p> <p>22 intervals where you've drilled 10 feet, you've</p> <p>23 got 3 feet of core. So you go, "Wait a minute,</p> <p>24 you know, "What have I missed?"</p>	<p style="text-align: right;">Page 345</p> <p>1 MS. O'DELL:</p> <p>2 Object to the form. He just stated</p> <p>3 that there are numerous other references. You're</p> <p>4 misstating his testimony.</p> <p>5 A This -- this document doesn't say that</p> <p>6 they're avoiding it. I don't think it does.</p> <p>7 MR. FROST:</p> <p>8 Q Well, this document says where it is in</p> <p>9 the ore body; correct?</p> <p>10 A Absolutely.</p> <p>11 Q And we know from your report, even, you</p> <p>12 state that there's a margin of exclusion. So</p> <p>13 anything extending --</p> <p>14 What do they say?</p> <p>15 -- quote, a couple of inches into the</p> <p>16 contacting talc ore we know would be outside of</p> <p>17 the exclusion area, which you said was at least</p> <p>18 one bucket.</p> <p>19 MS. O'DELL:</p> <p>20 Object to the form. Misstates his</p> <p>21 report.</p> <p>22 A No. I -- I don't agree with that at</p> <p>23 all. I mean, that was why I gave the example.</p> <p>24 If the margin of the ore body is a</p>

<p style="text-align: right;">Page 346</p> <p>1 straight, flat plane, that's one thing. You</p> <p>2 can -- if you've got something going two inches</p> <p>3 into it, by George, stay five feet away.</p> <p>4 But that's not what the margins of</p> <p>5 these ore bodies are like. They're irregular.</p> <p>6 MR. FROST:</p> <p>7 Q Okay.</p> <p>8 A And, so, if you're gonna produce a mine</p> <p>9 plan that assumes that you've got two inches of</p> <p>10 an asbestiform mineral here and so you -- you</p> <p>11 plan your scope or your bench based on that but</p> <p>12 your bench may be 15 feet this way and you're</p> <p>13 assuming that it's here, well, this thing could</p> <p>14 be irregular, and the margin of the ore body may</p> <p>15 be over here and you don't know it because your</p> <p>16 next drill hole is way up here.</p> <p>17 Q Okay.</p> <p>18 A That's what I'm trying to say.</p> <p>19 Q And it sounds like your opinion is a</p> <p>20 problem with all mining, because that's true of</p> <p>21 every ore body that's gonna be irregular;</p> <p>22 correct?</p> <p>23 MS. O'DELL:</p> <p>24 Object to the form.</p>	<p style="text-align: right;">Page 348</p> <p>1 types of mining, that you are relying on the</p> <p>2 quality of the mine supervisor and the data in</p> <p>3 order to define where the ore body is. Is that a</p> <p>4 fair statement?</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A I think that that's, you know, that</p> <p>8 could be the opening sentence on a paragraph on</p> <p>9 ore reserve estimation.</p> <p>10 MR. FROST:</p> <p>11 Q Okay.</p> <p>12 A I mean, it's just standard -- you know,</p> <p>13 standard protocol in mining. You take all your</p> <p>14 data and figure out where the ore is.</p> <p>15 Q Then later, turning back to 37, next</p> <p>16 sentence down, you wrote, "By 2006, all Imerys</p> <p>17 Vermont talc production was from a single open</p> <p>18 pit in the Argonaut mine that produced 150,000</p> <p>19 tons of talc per year," and you note "none used</p> <p>20 for cosmetic purposes in the United States</p> <p>21 (Imerys 499538)."</p> <p>22 Correct?</p> <p>23 MS. O'DELL:</p> <p>24 I'm sorry. Where are you?</p>
<p style="text-align: right;">Page 347</p> <p>1 MR. FROST:</p> <p>2 Q And it's not specific to what's going</p> <p>3 on here. I believe this is the Hamm mine.</p> <p>4 A It --</p> <p>5 MS. O'DELL:</p> <p>6 Object to the form.</p> <p>7 A It can be better or worse. But -- but</p> <p>8 the idea is, yes, ore bodies are, you know --</p> <p>9 with some exceptions, they can be irregular</p> <p>10 things. And it's very common to have wall rock</p> <p>11 mixed in with ore when you're over near the side</p> <p>12 of an ore body. And -- and in these, it's pretty</p> <p>13 tough to know, particularly underground. It's</p> <p>14 rough.</p> <p>15 MR. FROST:</p> <p>16 Q Okay. But, again, that's what the mine</p> <p>17 supervisor's for. That's why you have these</p> <p>18 drilling campaigns; correct?</p> <p>19 A That's right.</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 MR. FROST:</p> <p>23 Q And, you know, so what you're saying is</p> <p>24 a basic statement that applies to, you know, all</p>	<p style="text-align: right;">Page 349</p> <p>1 A I think that's right.</p> <p>2 MR. FROST:</p> <p>3 37 to 38.</p> <p>4 MS. O'DELL:</p> <p>5 Oh, at the bottom. Okay.</p> <p>6 MR. FROST:</p> <p>7 The bottom.</p> <p>8 Q Next sentence is, "Serpentine and</p> <p>9 arsenic occurred near the edges of the ore zone,</p> <p>10 and ore quality control by segregation of the</p> <p>11 mine was inadequate."</p> <p>12 Okay. You'll agree with me now, by</p> <p>13 2006, again, Johnson & Johnson was no longer</p> <p>14 using Vermont talc for its cosmetic talcum</p> <p>15 powder?</p> <p>16 A Correct.</p> <p>17 Q Okay. And you'll also agree with me</p> <p>18 that, by this point, the mine itself was</p> <p>19 producing industrial talcs. Correct?</p> <p>20 A I think that's correct.</p> <p>21 Q Okay. Staying on 38 --</p> <p>22 Bear with me a second here. I guess</p> <p>23 more of a general question than specific</p> <p>24 question, but you'd agree with me, based on the</p>

<p style="text-align: right;">Page 350</p> <p>1 documents that you have, that you can't make a 2 full map of sampling frequency, where exactly 3 samples were coming from, you know, how they 4 were -- how they were being taken. I think we 5 covered this earlier. Is that correct? 6 MS. O'DELL: 7 Object to the form. What type of -- 8 MR. FROST: 9 Q You know, there are -- there are holes 10 in the documents about frequency of testing, 11 frequency of sampling, things of that nature. 12 Correct? 13 A Are you talking about in the mine or in 14 the mill of -- 15 Q In general in the mines. Exactly. 16 MS. O'DELL: 17 Excuse me. Object to the form. 18 What specific types of -- 19 MR. FROST: 20 Well, that's what we were trying to 21 define. 22 Q You know, we're talking about in 23 general. You know, we'll start with there 24 appears to be -- you know, you don't have a</p>	<p style="text-align: right;">Page 352</p> <p>1 composite on the back end. Correct? 2 MS. O'DELL: 3 Object to the form. 4 A The -- 5 I think that -- that your statement is 6 correct, based on what your own documents say. 7 MR. FROST: 8 Q Uh-huh. 9 A You know, they say, you know, sampling 10 intervals will be such and so, at what points 11 they're gonna be. 12 We know that we don't have all the data 13 for -- for the mines. Because if they're gonna 14 analyze the cutting from blast holes, there's got 15 to be just tons of analyses out there. 16 Q Okay. 17 A And -- and -- and, in the mill, it's 18 very difficult to know because, you know, when 19 you're looking at -- at compositing samples that 20 are taken, you know, that -- that becomes a 21 different issue in itself. 22 Q Okay. All right. We're in agreement 23 that you certainly -- whether or not it was 24 produced, not produced, you know, you don't have</p>
<p style="text-align: right;">Page 351</p> <p>1 complete -- you don't have a complete set of all 2 drill core sampling; correct? 3 MS. O'DELL: 4 Object to the form. 5 MR. FROST: 6 Q In your documents. 7 A I don't know that. 8 Q Okay. But you cert- -- there certainly 9 doesn't appear that you have -- and I think 10 you've identified earlier that you appear to be 11 missing years and missing drill core area; 12 correct? 13 MS. O'DELL: 14 Object to the form. He didn't say that 15 in his testimony. Not in regard to drill core. 16 A We -- we have maps that show the 17 location of drill holes. We do not have logs for 18 all of those drill holes. 19 MR. FROST: 20 Q Okay. And the same thing with 21 sampling. It does not appear that you have a 22 complete set of the sampling records; correct? 23 A For the mines? 24 Q For the mines, the mill, and for the</p>	<p style="text-align: right;">Page 353</p> <p>1 a complete set of all the sampling that was done 2 at the mines, mills, and on the composite back 3 end. Is that a fair summary? 4 MS. O'DELL: 5 Object to the form. 6 A Yeah. 7 MS. O'DELL: 8 "Composite back end," I'm not sure what 9 you're referring to. 10 MR. FROST: 11 Q Yeah. The composite back end testing 12 of the -- 13 A Yeah. I think the word -- 14 Q -- the ground product. 15 A -- isn't "sampling," but we don't have 16 a complete set of analytical data. We know about 17 the sampling, but it's -- it's the data and more 18 information related to the data that we don't 19 have. 20 Q Okay. That's a more precise way of 21 saying it. 22 A Yeah. Sure. 23 Q Okay. Turn to page 39. 24 A Okay.</p>

<p style="text-align: right;">Page 354</p> <p>1 Q You say, quote, "It is inadequate -- it 2 is inadequate to collect a single daily or hourly 3 hand or grab sample from an ore stockpile in 4 front of a crusher, or from a conveyor belt 5 leaving a grinding circuit, and assume that this 6 one sample or a composite, perhaps a kilogram in 7 size, is representative of a day's production of 8 several hundred tons." 9 Did I read that correctly? 10 A Yep. 11 Q Don't you agree with me the only way to 12 determine whether or not a sample is actually 13 representative of the whole is to conduct a 14 geostatistical analysis of that sample versus the 15 size? 16 MS. O'DELL: 17 Object to the form. 18 A Well, I think that it's much more than 19 that. I would -- I would say that -- that, if I 20 was designing a sampling program for, let's say, 21 the West Windsor mill, I would want to have a 22 person that was in charge of sampling and 23 analyses. 24 We have somebody like that at one of</p>	<p style="text-align: right;">Page 356</p> <p>1 sample was taken. 2 A Right. You may have a day that it is, 3 but the problem is you may have a day when it 4 really isn't and something slips by that you 5 don't want to slip by. 6 Q But what I'm getting at is the only way 7 to truly derive if something is representative is 8 to run the -- 9 You know, all of the literature agrees 10 that the only way to truly determine something is 11 representative or not is to run a statistical 12 analysis of it; correct? 13 MS. O'DELL: 14 Object to the form. 15 A You -- you determine the -- the 16 confidence interval of the process that you're 17 proposing. And if you wanted to have something 18 that you were 95 percent confident was correct, 19 then, you know, you begin to work backwards and 20 take a look at how you're sampling. 21 MR. FROST: 22 Q Okay. 23 A I mean, that's a process -- a technique 24 that's been around for a long time.</p>
<p style="text-align: right;">Page 355</p> <p>1 our mines up the road here. It adds a nickel a 2 ton to the cost of our production, and -- and yet 3 we are able to sample daily multiple times and 4 run all the samples that day, and at the end of 5 the day, we know what's gone in the railcar. 6 There is no ambiguity at all. 7 And that's not what -- what's been 8 done. 9 MR. FROST: 10 Q Okay. 11 A I mean, you can't just grab a few 12 pieces of rock and analyze them and say, "Oh, 13 that's -- that's representative of what we mined 14 today." 15 "Well, how many tons did you mine?" 16 "Oh, it was three or four hundred 17 tons." 18 That doesn't work. 19 Q Well, let's see. Even you say, the 20 next sentence down, that -- you say -- you 21 yourself say it may or may not be representative; 22 correct? You say it may or may not be 23 representative of the material processed on the 24 individual sample -- on the day the individual</p>	<p style="text-align: right;">Page 357</p> <p>1 But it's very difficult to apply that 2 to feed coming into a plant. And that was my 3 point. You know, if you don't -- if you don't 4 have a formal sampling, you know, analysis 5 program set up where ore enters the mill or, 6 let's say, enters a stockpile that's gonna feed 7 the mill from, then -- then I think that you've 8 got an issue right from the very start. Because 9 no matter what you feed your statistical 10 analysis, if you're not collecting your samples 11 properly, it's not -- not gonna matter what the 12 mass says. 13 And believe me, we've -- we've been 14 gigged on this. We have had railcars -- 15 We ship out in 60-car lots, and we have 16 had whole trainloads rejected because of 17 out-of-spec ore in one car. And when you're 18 losing 60 -- 59 other cars that are probably 19 good, I mean, this -- this is an important point. 20 Q Okay. You'd agree with me the reason 21 you say you may or may not be representative is 22 because you haven't done any calculations as to 23 the confidence interval; correct? 24 MS. O'DELL:</p>

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1 Object to the form. Misstates his
2 testimony.
3 A No. Like I said, I haven't done any
4 mathematical analysis of anything. But I've
5 certainly been involved with exactly what we're
6 talking about forever more. I mean, it's a --
7 it's a serious point with me.
8 MR. FROST:
9 Q But, again, your conclusion here isn't
10 that it absolutely is or it absolutely is not.
11 You say it may or may not be. That's your --
12 that's your ultimate conclusion. That's correct?
13 A Any --
14 MS. O'DELL:
15 Excuse me.
16 THE WITNESS:
17 Yeah. Sure.
18 MS. O'DELL:
19 Object to form.
20 A Any given example may or may not be in
21 that.
22 MR. FROST:
23 Q All right. Page 40. It's technically
24 the second full paragraph there, third paragraph

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1 on the page, bottom two sentences:
2 Five particles of the same asbestiform
3 mineral were required for asbestos to be
4 considered quantifiable. Amounts less than this
5 were considered background or below detection
6 limits. This suggests that something may [sic]
7 be quantifiable if present, and this is not the
8 case.
9 Did I read that correctly?
10 MS. O'DELL:
11 "Must be"?
12 MR. FROST:
13 Yes.
14 Q Must be quantifiable if present, and
15 this is not the case.
16 A Yeah.
17 Q Okay.
18 A That -- that's -- that's right.
19 Q All right. Are you an expert in
20 designing TEM test methodologies?
21 A No.
22 Q Have you ever designed test
23 methodologies for testing asbestos in talc?
24 A No.

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1 Q You'll -- we will agree that TEM is an
2 appropriate instrument to use to test to see if
3 there is asbestos in talc; right?
4 A Yes.
5 Q And I take it your issue with this
6 parameter is the five-fiber detection limit?
7 A Well, I can explain it maybe a little
8 bit better than I stated it.
9 If you have a background that is one
10 and you find three fibers and, yet, to be
11 quantifiable you need five, then why aren't the
12 three fibers reportable since they are over the
13 background?
14 That's -- that was the concept in what
15 I wrote there. And it almost seems like the use
16 of quantifiability is evading the issue of tiny
17 amounts of material that may be there but in a
18 small increment over the -- the background.
19 Q Have you calculated what you determine
20 to be the proper detection quantifield --
21 quanti- --
22 A I know.
23 Q You know the word I'm trying to say?
24 A Right.

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1 Q Have you run a calculation to detect
2 what the appropriate level should be?
3 MS. O'DELL:
4 Object to the form.
5 A Well, like I said, I'm not a -- I'm not
6 a statistician. But I have -- I have done some
7 back-of-the-envelope, and -- and this is -- this
8 is what I see.
9 If you take a hundred analyses, 95 of
10 them show nothing, five of them show one fiber,
11 and those hundred analyses are of blanks, then
12 what are you gonna call your background if 95 of
13 them show nothing? I would say that background
14 is zero.
15 If background is zero, then if you find
16 four fibers, there's something in that sample,
17 and yet it's not quantifiable. And, so, from the
18 standpoint of that kind of math, yeah. I mean,
19 but anybody can do that.
20 Q Do you know who Walter McCrone is?
21 A Sure.
22 Q And do you know who James Millette are?
23 A Well, we've been talking about
24 Millette. I don't think that I know James

<p style="text-align: right;">Page 362</p> <p>1 Millette.</p> <p>2 Q Okay.</p> <p>3 A We know some Millettes but not him.</p> <p>4 Q All right. Would you agree with me</p> <p>5 that Walter McCrone is generally considered to be</p> <p>6 a leader in the field of TEM testing and</p> <p>7 technologies?</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A He is certainly a leader in polarized</p> <p>11 light microscopy. And I think that -- that, as</p> <p>12 time went on, he became a real expert in TEM</p> <p>13 analysis.</p> <p>14 MR. FROST:</p> <p>15 Q And because it seems like you know a</p> <p>16 bunch of Millettes but not the James Millette,</p> <p>17 you can't tell me whether or not he's a leader --</p> <p>18 A Well, there's a Millette that was a</p> <p>19 mining engineer, mining geologist here in</p> <p>20 Alabama. And we were wondering if this Millette</p> <p>21 was related to him, and we found out he wasn't.</p> <p>22 Q I was gonna say, you know, I actually</p> <p>23 know the answer.</p> <p>24 All right. I'd like to mark this</p>	<p style="text-align: right;">Page 364</p> <p>1 it down at the bottom, and I can't read it. It's</p> <p>2 minuscule.</p> <p>3 Q I believe it's 1990, by the -- the</p> <p>4 journal.</p> <p>5 A Okay.</p> <p>6 Q If you look to the first page on the</p> <p>7 journal, Volume 38, Fourth Quarter, 1990.</p> <p>8 A Oh. Okay. I've got it. Sure.</p> <p>9 MS. O'DELL:</p> <p>10 Yeah. And Kremer, K-R-E-M-E-R.</p> <p>11 MR. FROST:</p> <p>12 Yeah, K-R-E-M-E-R. "Creamer," maybe.</p> <p>13 Q Turn to page 463. Under number 6,</p> <p>14 Limit of Quantifiable Detection.</p> <p>15 A Okay.</p> <p>16 Q Do you see here that they note "The</p> <p>17 detection limit of five or more asbestiform</p> <p>18 minerals of one variety in an analysis</p> <p>19 constitutes a quantifiable level of detection"?</p> <p>20 A Right.</p> <p>21 Q And you agree with me that that's the</p> <p>22 same level of quantification in the J&J</p> <p>23 specifications?</p> <p>24 MS. O'DELL:</p>
<p style="text-align: right;">Page 363</p> <p>1 article as 31.</p> <p>2 THE COURT REPORTER:</p> <p>3 30. It's gonna be 30.</p> <p>4 MR. FROST:</p> <p>5 30. Sorry. I was looking at your</p> <p>6 stickers to try to figure out.</p> <p>7 (DEPOSITION EXHIBIT NUMBER 30</p> <p>8 WAS MARKED FOR IDENTIFICATION.)</p> <p>9 MR. FROST:</p> <p>10 Q Have you ever heard the publication</p> <p>11 Microscope?</p> <p>12 A I have. But I don't get it.</p> <p>13 Q It's not one you subscribe to or read?</p> <p>14 A No.</p> <p>15 Q But -- and you at least do recognize</p> <p>16 that it is a peer-reviewed publication that's out</p> <p>17 there?</p> <p>18 A It's out there.</p> <p>19 Q And, looking at page 457, do you see</p> <p>20 that the name of this article is "A Standard TEM</p> <p>21 Procedure for Identification and Quantification</p> <p>22 of Asbestiform Minerals in Talc"? Then it lists</p> <p>23 Kremer, James Millette.</p> <p>24 A Yeah. I'm trying to read the date on</p>	<p style="text-align: right;">Page 365</p> <p>1 Object to form.</p> <p>2 A That's the number that's in -- in</p> <p>3 most --</p> <p>4 I've seen four a couple of times, but I</p> <p>5 think five is -- is the one I see the most.</p> <p>6 MR. FROST:</p> <p>7 Q Okay. So you agree with me, anyway,</p> <p>8 that the five, you know --</p> <p>9 A Right.</p> <p>10 Q -- is in line with the limit of</p> <p>11 quantifiable detection published in the</p> <p>12 Microscope --</p> <p>13 A Right.</p> <p>14 Q -- in fourth quarter of 1990?</p> <p>15 A Correct.</p> <p>16 Q Okay. Turn to page 41.</p> <p>17 A Okay.</p> <p>18 Q And I'm not gonna belabor the point</p> <p>19 because I think we talked about this pretty</p> <p>20 significantly when we were looking at the Chinese</p> <p>21 document. But the second paragraph after Testing</p> <p>22 Methodologies, halfway through, you write that,</p> <p>23 "Finally" -- in the sentence that starts</p> <p>24 "Finally, an Imerys talc letter in 2013 states,"</p>

<p style="text-align: right;">Page 366</p> <p>1 and it goes on.</p> <p>2 And at the very bottom of this, "This,</p> <p>3 of course, suggests an asbestos content of less</p> <p>4 than .1 is acceptable, which is contrary to</p> <p>5 Defendants' policy that its products be</p> <p>6 asbestos-free."</p> <p>7 This is the same opinion you had as to</p> <p>8 the Chinese test; right? Correct?</p> <p>9 A No. No. This is different. I -- I</p> <p>10 was surprised to even see that because it looked</p> <p>11 like that suddenly we're gonna accept an asbestos</p> <p>12 content up to .1. I mean, to me, it read very</p> <p>13 strangely. I wasn't sure that it was even</p> <p>14 written the way it was meant to sound.</p> <p>15 Q Oh. I see.</p> <p>16 A Yeah. I mean, if you -- if you go back</p> <p>17 and look at the document, it almost sounds like</p> <p>18 they're saying, "Well, you know, we've done the</p> <p>19 best we can, but if it's got .09 percent</p> <p>20 asbestos, well, that's below the .1 accepted</p> <p>21 standard, so" --</p> <p>22 You know, it seemed like a very</p> <p>23 peculiar statement.</p> <p>24 Q I see. So the -- it's -- the notation</p>	<p style="text-align: right;">Page 368</p> <p>1 Exhibit 31.</p> <p>2 (DEPOSITION EXHIBIT NUMBER 31</p> <p>3 WAS MARKED FOR IDENTIFICATION.)</p> <p>4 MR. FROST:</p> <p>5 Q We're gonna turn gears a little bit</p> <p>6 here. Just to make it easier, I've put a</p> <p>7 collection of documents together in one binder so</p> <p>8 we don't have to worry about --</p> <p>9 A Oh, wonderful.</p> <p>10 Q -- running everything around.</p> <p>11 A Okay.</p> <p>12 Q So looking at page 13 of your report,</p> <p>13 running through page 21, this is the chart we</p> <p>14 talked about, you know, earlier --</p> <p>15 A Right, right.</p> <p>16 Q -- that has the various asbestos.</p> <p>17 A Right.</p> <p>18 Q And you've looked at each of these</p> <p>19 documents, you testified, that relates to the</p> <p>20 various entries on this chart?</p> <p>21 A Yes.</p> <p>22 Q And, sitting here today, can you tell</p> <p>23 me confidently that every one of the positive</p> <p>24 test results on this chart, you know, relates to</p>
<p style="text-align: right;">Page 367</p> <p>1 here is more the peculiarness of the statement</p> <p>2 and the document --</p> <p>3 A Well, if it's -- if it's accurate,</p> <p>4 then -- then -- then it means that everything has</p> <p>5 changed suddenly, that we're not -- we're not</p> <p>6 talc -- we're not asbestos-free and, in fact,</p> <p>7 we're gonna accept it up to .1.</p> <p>8 Q You'd agree with me -- this is what we</p> <p>9 covered before -- the test specification for</p> <p>10 Johnson & Johnson's talc is utilizing the FDA</p> <p>11 J4-1, which is the XRD testing method, followed</p> <p>12 by PLM; correct?</p> <p>13 A Correct.</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 MR. FROST:</p> <p>17 Q And we've also seen that there's TEM</p> <p>18 testing requirement, too, in the J&J talc</p> <p>19 specification; correct?</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 A Correct.</p> <p>23 MR. FROST:</p> <p>24 Q All right. I'm gonna mark this as</p>	<p style="text-align: right;">Page 369</p> <p>1 asbestos that made its way to a final bottle of</p> <p>2 talcum powder sold by Johnson & Johnson?</p> <p>3 A No.</p> <p>4 Q Okay.</p> <p>5 A I think that there may be a mistake or</p> <p>6 two on here.</p> <p>7 Q Okay. And we're gonna walk through a</p> <p>8 couple.</p> <p>9 A Okay.</p> <p>10 Q I'm not gonna call out every mistake</p> <p>11 because we'll be here -- you know, I'm not gonna</p> <p>12 look at every document and call out every</p> <p>13 mistake, but I do want to go through a few.</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 MR. FROST:</p> <p>17 Q So if we could look at what's been</p> <p>18 marked as Tab 1 in the binder of 31.</p> <p>19 A Right.</p> <p>20 Q This relates to an 8-2-22 --</p> <p>21 Well, first, if you look at page 18 of</p> <p>22 your report, sort of halfway down, for the test</p> <p>23 result for 8-22-1985.</p> <p>24 A Okay.</p>

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<p>1 Q All right. Do you see that references 2 document JNJMX68 -- 3 A Yes. 4 Q -- 13019? 5 A Right. 6 Q And that's talking about McCrone 7 project number ME-1862 and specifically samples 8 WMI85-28 and WMI85-30? 9 A Right. 10 Q Okay. If you'd turn to Tab 1 of the 11 exhibit blinder, you'll agree that this is the 12 corresponding document, and we see WMI85-28 -- 13 A Yes. 14 Q -- and 85-30 listed? 15 A Yes. 16 Q Okay. And, from this document, you 17 can't tell where the samples WMI85-28 and 18 WMI85-30 were mined; correct? 19 MS. O'DELL: 20 Object to the form. 21 A I don't think I can. 22 MR. FROST: 23 Q If you turn to -- 24 A I think that they actually -- the</p>	<p>1 that samples TC-700 were actually talc mined at 2 San Andreas, California; correct? 3 A It would seem to say that, yeah. 4 Q Okay. All right. Looking back at your 5 report, the next entry down, 4-29-1986, it's on 6 page 18. 7 A Okay. Tab 4? 8 Q Yeah. If you turn to Tab 4 here. 9 You're ahead of me already. 10 A Okay. 11 Q But on the chart you identify J&J182 as 12 the source document. Do you agree with me that 13 Tab 4 is Exhibit J&J182? 14 A Yes. 15 Q And, again, on your chart, you just 16 have talc samples, but here the talc samples 17 listed are WMI85-53, WMI85-55, and WMI85-57; 18 correct? 19 A Right. 20 Q Okay. 21 All right. If you'll look back at Tab 22 3. I'm sorry. Turn to page 5. I apologize. 23 Third page. 24 VIDEOGRAPHER:</p>
Page 371	Page 373
<p>1 sample numbers relate to the mill, not the mine. 2 Q Well, we'll -- why don't we turn to Tab 3 2. This is a document Bates numbered JNJ65646. 4 And I'll turn your attention to the second page. 5 A Okay. 6 Q Then we see here it says WMI85-28 and 7 it describes as grade TC-7- -- 8 A Right. I'm aware of those two. I 9 spotted them. 10 Q Okay. The grade TC-700? 11 A Right. I see that. 12 Q So if we turn to the tab marked 3, 13 which is a document that starts with Bates Imerys 14 013723, and if you can turn to the fourth page of 15 that. It's the one that's 13725. 16 A Okay. 17 Q Under Production Location, the second 18 one, San Andreas, California. 19 A Correct. 20 Q And then if you go over, it says 21 "Grade," and then it has "TC-700, light and 22 dark." 23 A Right. 24 Q So, by this document, it's indicating</p>	<p>1 Jack, did you put your mic on? 2 MR. FROST: 3 Oh, did it fall off? No. I took it 4 off. 5 Q So look at the page that ends 890. 6 A Okay. 7 Q And if you'll look up there, we see 8 WMI85-53. And, again, that's Grade TC-700? 9 A Right. 10 Q 85-55, also Grade TC-700. 11 A Okay. 12 Q And then the 85-57 is also grade 13 TC-700. 14 A Okay. 15 Q Okay. And, you know, as we saw last 16 time, the Grade TC-700 comes from San Andreas, 17 California; correct? 18 A Yeah. I'd have to go back and look, 19 but I -- I think it is. 20 Q Okay. You can look if you want, but I 21 take it you believe me on that one? 22 A Okay. 23 Q Okay. Look at page 17 of your report. 24 Right in about the middle, there's a 10-10-1974</p>

<p style="text-align: right;">Page 374</p> <p>1 entry on the -- on the chart. 2 A I see it. 3 Q Okay. And it accounts for J&J-74 as 4 the source document. 5 A Hang on. What was the date again? 6 Q 10-10-1974. It's about the middle of 7 page 17. 8 A Right. Right. I'm looking at the 9 other one. 10 Huh. Page 17? 11 Q Yeah. Here. I've highlighted it on 12 this one. I'll just let you look. Looks like 13 the second entry on page 17. 14 A Okay. I've got it. Sure. 15 Q And the source document for that entry 16 is J&J-74. 17 A Right. 18 Q Okay. If you look at Tab 8, do you 19 agree with me that that's the source document? 20 MS. O'DELL: 21 Tab 8? 22 MR. FROST: 23 Tab 8, yes. Oh, sorry. Tab 6. Looked 24 like an 8 as I was glancing at it.</p>	<p style="text-align: right;">Page 376</p> <p>1 that D-GI is an industrial product? It's not a 2 cosmetic talcum powder? 3 A Right. 4 Q All right. If you turn to page 15. 5 Oh, sorry. 14. About halfway down 14, there's a 6 document or there's an entry on the chart, 7 7-7-1971. And the what was tested column shows 8 that it was talc product 344-L? 9 A Right. 10 Q Okay. If you look at Tab 8, there's a 11 document JNJAZ55-6089 that appears to be -- you 12 know, it's the July 7, '71, letter that talks 13 about 344-L testing. Do you agree? 14 MS. O'DELL: 15 Jack, can you give us a moment? 16 MR. FROST: 17 Sure. 18 MS. O'DELL: 19 Because we have it as a different -- 20 MR. FROST: 21 Yeah. I was gonna say, you have the -- 22 that's fine. If you can find the one you have, 23 that's great. 24 MS. O'DELL:</p>
<p style="text-align: right;">Page 375</p> <p>1 Q Tab 6. 2 A Okay. 3 Q And if you look at the highlighted 4 portion of that document, which is highlighted on 5 the original, it notes that the sample is DG -- 6 D-GI; correct? 7 A Yes. 8 Q In which they found the fibrous 9 asbestiform materials. 10 If you look at Tab 7, this is a 11 document that's Bates stamped JNJMX682659. 12 A Okay. 13 Q Third paragraph down, it states, "The 14 samples represented both the industrial minerals 15 produced at the Gassetts," and it says "GI" in 16 parentheses. 17 A Right. 18 Q Okay. And then if you skip down -- 19 A Yeah. I, incidentally, I picked this 20 one up. 21 Q This is the one you picked up? 22 A I -- well, it's one of the ones I 23 picked up. 24 Q All right. Do you agree with me, then,</p>	<p style="text-align: right;">Page 377</p> <p>1 Yeah. Just -- and it may be the same 2 document, but we identified it differently, so 3 just give us just a minute -- 4 MR. FROST: 5 Yeah. That's fine. 6 MS. O'DELL: 7 -- to check the Bates number. 8 MR. FROST: 9 Of course, the sticker's over the Bates 10 number; right? 11 MS. O'DELL: 12 Never helpful. 13 I believe that to be the same one. 14 MR. FROST: 15 Okay. 16 MS. O'DELL: 17 Thank you. 18 MR. FROST: 19 Q Okay. And this is a report from 20 Colorado Schools of Mines regarding this sample 21 344-L? 22 A Right. 23 Q Are you aware that the Colorado School 24 of Mines issued a subsequent report on retesting</p>

<p style="text-align: right;">Page 378</p> <p>1 of these same samples?</p> <p>2 A No.</p> <p>3 Q Turn to Tab 9.</p> <p>4 A I say I'm not. I -- I don't</p> <p>5 remember -- I don't remember seeing it. If it --</p> <p>6 if it contradicted this one, then I would have</p> <p>7 likely removed it from the table. So --</p> <p>8 Q Okay.</p> <p>9 A -- I either don't remember it or didn't</p> <p>10 see it.</p> <p>11 Q Okay. That's fair.</p> <p>12 Go on and turn to Tab 9. It's a</p> <p>13 document Bates-stamped JNJAZ55-3828.</p> <p>14 A Where was that in the table?</p> <p>15 Q This particular document?</p> <p>16 A Yeah. Are you referring to an entry in</p> <p>17 the table?</p> <p>18 Q It's not. I'm gonna -- this document</p> <p>19 refers -- this is the retest that I was talking</p> <p>20 about from Colorado School of Mines.</p> <p>21 A Oh, okay. Sure.</p> <p>22 MS. O'DELL:</p> <p>23 And if you haven't seen the document,</p> <p>24 take your time --</p>	<p style="text-align: right;">Page 380</p> <p>1 contamination from the standard asbestos</p> <p>2 samples."</p> <p>3 A Right.</p> <p>4 Q So, based on this, obviously, you know,</p> <p>5 we can't determine whether or not the sample</p> <p>6 344-L on the chart, you know, is an actual</p> <p>7 finding of asbestos in the talcum powder. Would</p> <p>8 you -- would you agree with that statement?</p> <p>9 MS. O'DELL:</p> <p>10 Object to form.</p> <p>11 A Hang on. I'm reading that third</p> <p>12 paragraph.</p> <p>13 MR. FROST:</p> <p>14 Q Sure.</p> <p>15 A Yeah.</p> <p>16 Q Okay.</p> <p>17 A Okay.</p> <p>18 Q Page 15, the second notation, 9-6-1972,</p> <p>19 J&J-31.</p> <p>20 A Right.</p> <p>21 Q And the source document is noted as</p> <p>22 J&J -- yeah, J&J-31.</p> <p>23 A Right.</p> <p>24 Q Turn to Tab 12. You'll agree with me</p>
<p style="text-align: right;">Page 379</p> <p>1 MR. FROST:</p> <p>2 Q I was gonna say take your time to read</p> <p>3 it. I believe it's pretty short.</p> <p>4 A Yeah.</p> <p>5 Q Actually, very short.</p> <p>6 A There they go again, "within our limits</p> <p>7 of detectability."</p> <p>8 Right. Okay.</p> <p>9 Q You're reading from the middle of</p> <p>10 paragraph 1?</p> <p>11 A I'm reading --</p> <p>12 Q The numbered paragraph 1?</p> <p>13 A I'm reading the last sentence of the</p> <p>14 second full paragraph.</p> <p>15 Q Yeah.</p> <p>16 So, before that, it states "Subsequent</p> <p>17 x-ray work" --</p> <p>18 A Right.</p> <p>19 Q -- "on the 6-month product samples on</p> <p>20 the 344-L product sample shows no definite</p> <p>21 indications of any asbestos-type minerals within</p> <p>22 our limits of detectability."</p> <p>23 A Right.</p> <p>24 Q "The trace amounts I saw were evidently</p>	<p style="text-align: right;">Page 381</p> <p>1 that appears to be the source document, that</p> <p>2 J&J-31?</p> <p>3 A Right.</p> <p>4 Q If you turn to page 4 of 7.</p> <p>5 A Okay.</p> <p>6 Q So the sample numbers that have</p> <p>7 chrysotile findings you agree are 133, 134, 137,</p> <p>8 138, and then, if you turn to the next page, 84?</p> <p>9 A Read those numbers again.</p> <p>10 Q Sure. 133, 134 --</p> <p>11 A Okay.</p> <p>12 Q -- then 137 and 138 and 84.</p> <p>13 A Right.</p> <p>14 Q Turn back -- or turn to Tab 11, which</p> <p>15 is a document dated January 7th, 1976. You can</p> <p>16 read the letter. But, effectively, this is a</p> <p>17 retest of some of the various samples by</p> <p>18 Dr. Lewin; correct?</p> <p>19 A Correct.</p> <p>20 Q If you turn to -- one, two, three --</p> <p>21 the fourth page. So if you see -- if you look at</p> <p>22 84 under chrysotile, there's a question mark.</p> <p>23 Then if you look at 133, 134, 137 and 138 under</p> <p>24 chrysotile, it's now marked "nondetect."</p>

<p style="text-align: right;">Page 382</p> <p>1 A Right. I see that. Uh-huh.</p> <p>2 Q So, again, just like the other</p> <p>3 document, based on the retesting, you know, we</p> <p>4 can't say one way or the other whether there was</p> <p>5 actually asbestos in that sample; correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A Correct.</p> <p>9 MR. FROST:</p> <p>10 Q Now, I know we've said this lots of</p> <p>11 times, and I apologize, but not a doctor, not a</p> <p>12 toxicologist; correct?</p> <p>13 A Correct.</p> <p>14 Q And, because of that, you can't testify</p> <p>15 to a reasonable degree of scientific certainty</p> <p>16 that any individual container of talcum powder</p> <p>17 has sufficient asbestos in it to cause ovarian</p> <p>18 cancer; correct?</p> <p>19 A Correct.</p> <p>20 MS. O'DELL:</p> <p>21 Object to the form.</p> <p>22 MR. FROST:</p> <p>23 Q Okay. And same thing. You can't</p> <p>24 testify that any particular container of talcum</p>	<p style="text-align: right;">Page 384</p> <p>1 me before, you know, sitting here today, you</p> <p>2 can't tell me that every single one of these --</p> <p>3 you know, any one of the ones that are left</p> <p>4 would, you know, also be indicative of something</p> <p>5 that actually ended up in talcum powder; correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A Well, it depends on what's being</p> <p>9 analyzed. If some of it is the finished product,</p> <p>10 then it's the finished product.</p> <p>11 MR. FROST:</p> <p>12 Q Okay.</p> <p>13 A If not, then, you know, it depends on</p> <p>14 where the sample was collected. If it was</p> <p>15 collected at the mine, then that's one thing. If</p> <p>16 it was collected coming out of the flotation</p> <p>17 circuit, well, you know, maybe it did get --</p> <p>18 probably it got in.</p> <p>19 Q Okay.</p> <p>20 A I'm not in the business of throwing --</p> <p>21 throwing good product away.</p> <p>22 Q And you also -- you can't tell me,</p> <p>23 sitting here, that there aren't other documents</p> <p>24 that may call into question or contradict some of</p>
<p style="text-align: right;">Page 383</p> <p>1 powder has sufficient asbestos in it to cause</p> <p>2 mesothelioma; correct?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A That's correct. You know, you -- the</p> <p>6 term "sufficient" is -- is an interesting one in</p> <p>7 your question. I don't know that anybody on</p> <p>8 earth knows that answer.</p> <p>9 MR. FROST:</p> <p>10 Q Okay.</p> <p>11 A Can -- can say that.</p> <p>12 Q But that's certainly not an area</p> <p>13 that -- it's not an area you've studied --</p> <p>14 A Right.</p> <p>15 Q -- or are qualified in.</p> <p>16 And, again, I think I've now pointed</p> <p>17 out five, I believe --</p> <p>18 A Yes.</p> <p>19 Q -- examples of, you know, sort of --</p> <p>20 I'll call them inaccuracies, you know, but --</p> <p>21 A Glitches.</p> <p>22 Q -- notations on the chart, you know,</p> <p>23 that we can't say whether or not are actually</p> <p>24 asbestos in the product. And I believe you told</p>	<p style="text-align: right;">Page 385</p> <p>1 the other testing results here; correct?</p> <p>2 MS. O'DELL:</p> <p>3 Object.</p> <p>4 MR. FROST:</p> <p>5 Q The -- the testing results listed here</p> <p>6 were based on, you know, your best efforts and</p> <p>7 reviewing the documents you had available at the</p> <p>8 time; correct?</p> <p>9 MS. O'DELL:</p> <p>10 Objection. Object to the form.</p> <p>11 A Yeah. The table is my best effort at</p> <p>12 putting together information from the documents</p> <p>13 that I had. That -- that statement's accurate.</p> <p>14 MR. FROST:</p> <p>15 Q Okay. Now, have you reviewed</p> <p>16 Dr. Longo's reports that have been issued in this</p> <p>17 case?</p> <p>18 A I'm not sure I've seen all of them.</p> <p>19 Q You've reviewed some of the Longo</p> <p>20 reports, at least?</p> <p>21 A Yes.</p> <p>22 Q Okay. And are you -- are you relying</p> <p>23 on the Longo test results as part of the basis</p> <p>24 for your opinions in these cases?</p>

<p style="text-align: right;">Page 386</p> <p>1 A Not really. I mentioned him a couple</p> <p>2 of times. But I got -- I got his report, his --</p> <p>3 I mean, the great big huge report -- just a few</p> <p>4 days ago.</p> <p>5 Q Oh, okay. So it's --</p> <p>6 A I'd seen the introductory materials and</p> <p>7 some of the earlier reports he had.</p> <p>8 Q But you're not specifically relying on</p> <p>9 Longo's testing and his testing methodologies and</p> <p>10 things like that for the basis of your opinions</p> <p>11 in this case?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form.</p> <p>14 A It is certainly part of the big</p> <p>15 picture.</p> <p>16 MR. FROST:</p> <p>17 Q You're not here to offer any opinions</p> <p>18 that his testing methodologies were inadequate or</p> <p>19 that, you know, his preparation procedures and</p> <p>20 things like that, they -- that's -- that's not</p> <p>21 part of the opinions you're offering in this</p> <p>22 case, are they?</p> <p>23 A No.</p> <p>24 Q Okay.</p>	<p style="text-align: right;">Page 388</p> <p>1 subject.</p> <p>2 VIDEOGRAPHER:</p> <p>3 Going off the record. The time is 4:13</p> <p>4 p.m.</p> <p>5 (OFF THE RECORD.)</p> <p>6 VIDEOGRAPHER:</p> <p>7 We're back on the record. The time is</p> <p>8 4:40 p.m.</p> <p>9 MR. FROST:</p> <p>10 Q Okay. I believe we were turning to</p> <p>11 page 22 of your report. No. Page 23.</p> <p>12 Did your report get lost somewhere?</p> <p>13 A Yeah. I'm looking for yours with the</p> <p>14 tabs on it.</p> <p>15 Q Oh. That's the binder on the bottom.</p> <p>16 MS. O'DELL:</p> <p>17 Do you need it?</p> <p>18 MR. FROST:</p> <p>19 We're gonna turn to it next, so it's a</p> <p>20 good thing you have it.</p> <p>21 Q Okay. So you see the 5-25-1972</p> <p>22 notation under the chart regarding fibrous talc?</p> <p>23 And it notes the source document is JNJ238826,</p> <p>24 248023?</p>
<p style="text-align: right;">Page 387</p> <p>1 A I did read -- I did read his methods.</p> <p>2 They seem to be up to snuff.</p> <p>3 Q Okay. You didn't do any, for example,</p> <p>4 calculations of BSAED dispersion patterns --</p> <p>5 A No.</p> <p>6 Q -- or you didn't try to verify any of</p> <p>7 his test results?</p> <p>8 A No. No, no, no. I'm not sure how I</p> <p>9 would have.</p> <p>10 Q That's -- that's not your area of</p> <p>11 expertise; correct?</p> <p>12 A Nor do I have the equipment.</p> <p>13 Q Well, that's a fair point, too.</p> <p>14 A Yeah.</p> <p>15 Q Turning to page 20 --</p> <p>16 Are these chronological? They are.</p> <p>17 Okay.</p> <p>18 MS. O'DELL:</p> <p>19 Hey, Jack. We've been going a</p> <p>20 hundred -- hour and 15 minutes. Can we take a</p> <p>21 short break?</p> <p>22 MR. FROST:</p> <p>23 Yeah. We can take a break now. This</p> <p>24 works well. I was moving on to a different</p>	<p style="text-align: right;">Page 389</p> <p>1 A Right.</p> <p>2 Q Turn to Tab 13.</p> <p>3 MS. O'DELL:</p> <p>4 You said 5-25-1972?</p> <p>5 MR. FROST:</p> <p>6 Yes. It's on page 23 of his report.</p> <p>7 MS. O'DELL:</p> <p>8 Okay. So you're not talking about the</p> <p>9 asbestos table. You're talking about the fibrous</p> <p>10 talc table.</p> <p>11 MR. FROST:</p> <p>12 Yeah, the fibrous talc table.</p> <p>13 MS. O'DELL:</p> <p>14 Okay. All right.</p> <p>15 MR. FROST:</p> <p>16 Q Okay. Do you agree with me these are</p> <p>17 the two source documents?</p> <p>18 A I think so.</p> <p>19 Q And they're both referring to sample</p> <p>20 FD-14?</p> <p>21 A I think that they are. Sure.</p> <p>22 Q All right.</p> <p>23 A I mean, I've looked at the first one of</p> <p>24 these.</p>

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<p>1 Are both documents behind the same tab?</p> <p>2 Q They are. There's a blue page</p> <p>3 separating the two.</p> <p>4 A Oh, okay. Thank you. Gotcha. Okay.</p> <p>5 Q And you'll also agree with me that</p> <p>6 they're talking -- the FD-14 seems to have been</p> <p>7 tested by a Dr. W. Smith at Fairleigh Dickinson</p> <p>8 University?</p> <p>9 A Correct.</p> <p>10 Q Okay. Turn to --</p> <p>11 A Wait a minute.</p> <p>12 MS. O'DELL:</p> <p>13 Dr. Smith? Is that what you were --</p> <p>14 MR. FROST:</p> <p>15 Q Dr. W. Smith, Fairleigh Dickinson</p> <p>16 University.</p> <p>17 Both of these are Johnson & Johnson</p> <p>18 documents, but they're talking about the</p> <p>19 Dr. W. Smith testing of the tremolite talc,</p> <p>20 FD-14.</p> <p>21 Do you agree with that statement?</p> <p>22 A Okay. I was looking for Smith's name.</p> <p>23 I remember seeing Rolle and Goudie and --</p> <p>24 Q If you look at the first document, the</p>	<p>1 Drs. Gamble and Gibbs --</p> <p>2 A Correct.</p> <p>3 Q -- entitled "An evaluation of the risks</p> <p>4 of lung cancer and mesothelioma from exposure to</p> <p>5 amphibole cleavage fragments"?</p> <p>6 A Correct.</p> <p>7 Q You can feel free to read the paper,</p> <p>8 but I'm gonna direct your attention to page 23 of</p> <p>9 33.</p> <p>10 A Oh, great. Okay. All right.</p> <p>11 Q Okay. Second column, looks like the</p> <p>12 second paragraph down, the paragraph starts,</p> <p>13 "Samples used in experimental studies."</p> <p>14 A Page 23 of 33?</p> <p>15 Q Yep. On the second column.</p> <p>16 A Second column being the right-hand</p> <p>17 column?</p> <p>18 Q Yeah. Then it starts right there. It</p> <p>19 says "Samples."</p> <p>20 A Okay.</p> <p>21 Q About halfway down in that paragraph --</p> <p>22 A Right.</p> <p>23 Q -- the sentence reads, "On the other</p> <p>24 hand, there are several studies of tremolitic</p>
Page 391	Page 393
<p>1 238826 --</p> <p>2 A Right.</p> <p>3 Q -- at the top, it says, "Subject,</p> <p>4 Characterization of Tremolite Talc, FD-14,</p> <p>5 Dr. W. Smith --</p> <p>6 A Oh. Oh, yeah.</p> <p>7 Q -- Fairleigh Dickinson University.</p> <p>8 A Right. I've got him. Yep. Yep. Yep.</p> <p>9 Sure.</p> <p>10 Q All right. Turn to Tab 14.</p> <p>11 A Okay.</p> <p>12 Q It's a letter dated March 15th, 1972,</p> <p>13 Bates stamped JNJ346879.</p> <p>14 A Okay.</p> <p>15 Q And, again, it's from -- you know,</p> <p>16 second sentence down says, "As you may remember</p> <p>17 from my brief conversation with you, we are</p> <p>18 presently analyzing a talc used by</p> <p>19 Dr. W. E. Smith in his animal testing. Could you</p> <p>20 please have the EM work done on this talc labeled</p> <p>21 FD-14?"</p> <p>22 A Sure.</p> <p>23 Q Okay. If you turn to Tab number 15,</p> <p>24 this is a paper published on October 22, 2007, by</p>	<p>1 talc samples from the Gouverneur mine in New York</p> <p>2 State." And the second one listed is FD-14 used</p> <p>3 by Dr. Smith, 1979. Is that correct?</p> <p>4 MS. O'DELL:</p> <p>5 That's what it states.</p> <p>6 MR. FROST:</p> <p>7 Q Or did I -- did I read that correctly?</p> <p>8 A I think you did.</p> <p>9 Q Okay. And, by this, it indicates that</p> <p>10 the tremolitic talc tested by Dr. Smith that's</p> <p>11 FD-14 is actually a Gouverneur mine sample;</p> <p>12 correct?</p> <p>13 MS. O'DELL:</p> <p>14 Object to the form.</p> <p>15 A Unless there's a peculiar duplication</p> <p>16 of numbers.</p> <p>17 MR. FROST:</p> <p>18 Q It certainly seems to indicate that;</p> <p>19 correct?</p> <p>20 A It would suggest that.</p> <p>21 Q Okay. If you turn to page 25 of your</p> <p>22 report, again on the fiber -- fibrous talc chart,</p> <p>23 an entry for 7-29-1975. And it indicates</p> <p>24 document JNJL6127053.</p>

<p style="text-align: right;">Page 394</p> <p>1 Do you see where I am?</p> <p>2 A Yeah, I've got it.</p> <p>3 Q Okay. And if you turn to Tab 16 in the</p> <p>4 binder that's Exhibit 31.</p> <p>5 A Okay.</p> <p>6 Q You agree with me that this is the</p> <p>7 source document for the entry on the chart;</p> <p>8 correct?</p> <p>9 A I believe it's the right number.</p> <p>10 Q Okay. Do you see up in the upper</p> <p>11 left-hand corner it says "W. Minerals, Ludlow</p> <p>12 36"?</p> <p>13 A Yes.</p> <p>14 Q Okay. And if you turn to Tab 17, which</p> <p>15 is a document Bates-stamped Imerys 013723.</p> <p>16 A Uh-huh.</p> <p>17 Q And if you turn to the second page,</p> <p>18 fourth entry down, it says "Ludlow, Vermont."</p> <p>19 A Got it.</p> <p>20 Q Okay. And it notes Grade 36 here.</p> <p>21 A I see Grade 36.</p> <p>22 Q Okay. And if you look down --</p> <p>23 So the production location of this is</p> <p>24 Ludlow, Vermont; correct? And then it says</p>	<p style="text-align: right;">Page 396</p> <p>1 still fibrous talc.</p> <p>2 Q Okay. But that's different than the</p> <p>3 talc that was sourced for Johnson & Johnson</p> <p>4 talcum powder; correct?</p> <p>5 A It may --</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A It may or may not be. I mean, if</p> <p>9 they're coming from --</p> <p>10 They list the mines, and they're the</p> <p>11 same mines that were producing the cosmetic talc,</p> <p>12 and there's no reason to think that -- that even</p> <p>13 though we've got lots of analyses that show</p> <p>14 fibrous talc in cosmetic talc that there</p> <p>15 shouldn't be any fibrous talc in industrial talc.</p> <p>16 It...</p> <p>17 MR. FROST:</p> <p>18 Q Okay. But, based on this, this</p> <p>19 certainly isn't evidence that there was fibrous</p> <p>20 talc that ended up in a bottle of Johnson's -- in</p> <p>21 Johnson & Johnson's talcum powder; correct?</p> <p>22 MS. O'DELL:</p> <p>23 Object to the form.</p> <p>24 A That way, no.</p>
<p style="text-align: right;">Page 395</p> <p>1 "Grade 36."</p> <p>2 A Correct.</p> <p>3 Q Okay. And if you look on the next</p> <p>4 page, that is different than the production</p> <p>5 location being Windsor, Vermont -- right? --</p> <p>6 which has the Grade 65 talc, which we know is the</p> <p>7 cosmetic talc?</p> <p>8 A Okay.</p> <p>9 Q And we know that the cosmetic talc came</p> <p>10 from the Windsor, Vermont, mill; correct?</p> <p>11 A It should have, yes.</p> <p>12 Q All right. And that's separate,</p> <p>13 according to this document, from the Ludlow,</p> <p>14 Vermont, mill; correct?</p> <p>15 MS. O'DELL:</p> <p>16 Object to the form.</p> <p>17 A Yes.</p> <p>18 MR. FROST:</p> <p>19 Q Okay.</p> <p>20 A I think that the point of all this is</p> <p>21 that the -- the mill feed at Ludlow had fibrous</p> <p>22 talc in it.</p> <p>23 Q Exactly.</p> <p>24 A Whether it was cosmetic or not, it was</p>	<p style="text-align: right;">Page 397</p> <p>1 MR. FROST:</p> <p>2 Q Okay. And, again, you know, we've</p> <p>3 already covered this before, but you can't tell</p> <p>4 me to a reasonable degree of scientific certainty</p> <p>5 that any individual container of talcum powder</p> <p>6 may have contained a sufficient number of -- or a</p> <p>7 sufficient amount of fibrous talc to cause any</p> <p>8 human disease; correct?</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 A I've never seen a paper that said how</p> <p>12 much you needed to cause any kind of a problem.</p> <p>13 MR. FROST:</p> <p>14 Q Okay. And that's outside of your area</p> <p>15 of expertise, anyway.</p> <p>16 A Correct.</p> <p>17 Q Okay. Now, again, you know, you've</p> <p>18 also noted on here, we've seen at various points</p> <p>19 nickel, chromium, cobalt and arsenic, I believe,</p> <p>20 as well. And you'd agree with me that not all of</p> <p>21 the entries on the charts for these various</p> <p>22 different chemicals are, in fact, finished talcum</p> <p>23 powder; correct?</p> <p>24 MS. O'DELL:</p>

<p style="text-align: right;">Page 398</p> <p>1 Object to the form.</p> <p>2 A Some are. Some are not.</p> <p>3 MR. FROST:</p> <p>4 Q Okay. And a lot of them, you know, are</p> <p>5 ore samples, things of that nature?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form. Object to the</p> <p>8 form, "a lot." What does that mean?</p> <p>9 MR. FROST:</p> <p>10 Q Many of them? You know, a certain</p> <p>11 number of them come from ore samples; correct?</p> <p>12 MS. O'DELL:</p> <p>13 Object to the form.</p> <p>14 A I would say that -- that ore is</p> <p>15 converted to finished product, and there's no</p> <p>16 indication that there's been any attempt to get</p> <p>17 those metals out. So that's my answer.</p> <p>18 MR. FROST:</p> <p>19 Q You'd agreed with me, if done properly,</p> <p>20 beneficiation could be used to lower the amounts</p> <p>21 of heavy metals that may appear in a finished</p> <p>22 product; correct?</p> <p>23 MS. O'DELL:</p> <p>24 Object to the form.</p>	<p style="text-align: right;">Page 400</p> <p>1 any Vermont talc with any other Vermont talc is</p> <p>2 gonna do nothing to lower potential heavy metal</p> <p>3 values found in the finished product?</p> <p>4 A It depends on whether you're including</p> <p>5 arsenic in there as a -- as a heavy metal. I</p> <p>6 don't -- I don't include arsenic as a heavy</p> <p>7 metal. But if you want to include it in there,</p> <p>8 blending can reduce the arsenic level.</p> <p>9 Q Okay. And arsenic's the only one that</p> <p>10 you believe that blending can reduce?</p> <p>11 A Haven't seen any indication that</p> <p>12 blending with anything else would -- would reduce</p> <p>13 those numbers.</p> <p>14 Q You also believe that there's no way to</p> <p>15 use beneficiation to, say, remove chlorite from</p> <p>16 talc?</p> <p>17 A I think that that could probably be</p> <p>18 done. And, in fact, my guess is that some of</p> <p>19 that is done. I think it's tough, because in</p> <p>20 a -- in a flotation plant, those two minerals</p> <p>21 tend to respond similarly. And, so, when you --</p> <p>22 when you -- they were using a methyl isobutyl</p> <p>23 something or another in one of the plants. That</p> <p>24 frothing agent is excellent for talc, but I think</p>
<p style="text-align: right;">Page 399</p> <p>1 A I don't think that there's been a</p> <p>2 single study that's indicated that.</p> <p>3 MR. FROST:</p> <p>4 Q And would you agree with me that</p> <p>5 blending is a technique that can be used to lower</p> <p>6 total heavy metal counts by using ores from</p> <p>7 different areas that have different</p> <p>8 concentrations of heavy metals?</p> <p>9 MS. O'DELL:</p> <p>10 Object to the form.</p> <p>11 A If I was asked to produce a blended</p> <p>12 talc that would lower the heavy metals, it would</p> <p>13 have to be blending Vermont talc with a</p> <p>14 non-Vermont source.</p> <p>15 Say we know that the metal numbers are</p> <p>16 low in Chinese talc. So if you wanted to have 50</p> <p>17 percent Chinese talc, 50 percent Ludlow talc,</p> <p>18 then your total metals are gonna go down.</p> <p>19 Q Okay.</p> <p>20 A So blending can do that. But there's</p> <p>21 no indication that anything like that was ever</p> <p>22 done other than blending Vermont talc with</p> <p>23 Vermont talc.</p> <p>24 Q And your opinion is that blending of</p>	<p style="text-align: right;">Page 401</p> <p>1 it's also pretty good for chlorite, too. I think</p> <p>2 that by playing around, you might come up with a</p> <p>3 frothing agent or an agent that might help pull</p> <p>4 chlorite out if you wanted to add a separate</p> <p>5 circuit.</p> <p>6 Q Okay.</p> <p>7 A But I don't know that that's true.</p> <p>8 This is -- this is -- based on what I've read and</p> <p>9 looked at, you might be able to do that. You'd</p> <p>10 have to try. It'd have to be bench -- bench</p> <p>11 scale testing.</p> <p>12 Q Okay. So you'd agree with me that,</p> <p>13 hypothetically, beneficiation, done properly,</p> <p>14 could remove the chlorite which would drop the</p> <p>15 levels of heavy metals contained in the talc?</p> <p>16 MS. O'DELL:</p> <p>17 Object to the form.</p> <p>18 A I would say that it might.</p> <p>19 MR. FROST:</p> <p>20 Q And, again, if I were to ask you --</p> <p>21 And I'll ask it as one question, which</p> <p>22 I know is compound, so there'll be an objection.</p> <p>23 But if I were to ask you with respect</p> <p>24 to arsenic, cobalt, chromium, nickel --</p>

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1 I believe that's all of them.

2 A Yep. That's it.

3 Q Okay. You couldn't tell me to any

4 degree of scientific certainty that any

5 individual container would contain enough of

6 these particular heavy metals to cause human

7 disease; correct?

8 MS. O'DELL:

9 Object to the form.

10 A I'm not an expert in human disease.

11 MR. FROST:

12 Q And are you also aware that chromium is

13 a fairly common --

14 Well, strike that.

15 Are you aware there's two different

16 types of chromium? Well, there's more than, but

17 there are two different types of chromium that

18 are generally recognized to be associated with

19 rocks?

20 A Right. Yes.

21 Q And that's chromium 3 and chromium 6?

22 A Correct.

23 Q Okay. And you're also aware that

24 chromium 6 is the one that causes concern;

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1 correct?

2 MS. O'DELL:

3 Object to the form.

4 A Yes. Plus 6 chromium is -- is, you

5 know, considered to be, you know, very bad.

6 MR. FROST:

7 Q Okay. And, in fact, chromium 3 is an

8 essential element to human bodies and everything

9 else.

10 MS. O'DELL:

11 Object to the form.

12 MR. FROST:

13 Q It's something human bodies need to

14 function.

15 A Uh-huh. Yes.

16 Q And you're also aware that cobalt 3 is

17 a common element found in rock.

18 A Cobalt 3?

19 Q Sorry. Chromium 3.

20 A Yes.

21 Q Okay. And you'll agree with me that

22 the chart and the testing results don't designate

23 whether or not it's chromium 3 versus chromium 6

24 they're finding in the talc samples; correct?

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1 A It's -- the -- the technique used by

2 Johnson & Johnson would not distinguish between

3 the two, and their -- their specs don't try to

4 distinguish between the two.

5 They have a -- they have a report --

6 it's actually quite -- quite interesting -- where

7 they have tried to determine how much of each was

8 present. And I didn't reference it, but I've got

9 it somewhere. But there was an attempt probably

10 back in the late 1970s to look at this.

11 Q You'd agree with me, based on the

12 sampling results that you rely on for your

13 report, you can't tell whether or not it's cobalt

14 3 versus -- I'm sorry --

15 A Chromium.

16 Q -- chromium 3 versus chromium 6 in the

17 talc; correct?

18 A They don't report it that way.

19 MS. O'DELL:

20 Object to the form.

21 A They report total chromium.

22 MR. FROST:

23 Q Okay.

24 A Pardon me. I'm not even sure they're

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1 reporting total chromium because that -- that is

2 based on what extraction technique they used.

3 Q Okay. I'm gonna switch gears and turn

4 to Exhibit 4, which are your invoices. And one

5 thing I noticed as I was going through,

6 variously, invoices have notations with meeting

7 with, like, for example, invoice number 5,

8 meeting with potential expert witnesses, Brian

9 Fowler and Don Burns.

10 A Right.

11 Q Who are Brian Fowler and Don Burns?

12 A Don Burns is the chief geologist for

13 Omnia in Vermont, and he and I are friends.

14 And Brian Fowler, remember the citation

15 of Chidester, Billings, and Cady?

16 Q Uh-huh.

17 A Brian Fowler's father-in-law was Marlin

18 Billings, the Billings in that report. And he is

19 a consulting geologist that lives in

20 New Hampshire, right across the line, and he owns

21 or owned a company called North American

22 Preserve -- Reserve that did an awful lot of work

23 up there. And -- but, unfortunately, not much of

24 it was related to talc mining, and I didn't know

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1 that.

2 And, so, at one point, since I was up

3 there, I said, "I'm gonna look up Brian" Brian

4 Fowler had worked down here in Alabama. That's

5 how I knew him.

6 So I looked him up, and he said, you

7 know, "I don't know enough about it to be of any

8 help."

9 Q Okay. So that was the nature of your

10 conversation with Brian Fowler is just --

11 A Yeah, sure.

12 Q -- I'm working on this; would you be

13 interested; and he said, "Unfortunately, I'm not

14 qualified"?

15 A Same with Don burns, and his answer was

16 "Hell, no."

17 Q I was gonna say. So who's Don Burns?

18 A He's the chief geologist for Omnia.

19 Q Okay.

20 A Their account producer there.

21 Q And did Mr. Burns express to you why he

22 was not interested in --

23 A He's retiring, didn't want to be

24 involved. In fact, he's probably retired now.

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1 But he was, you know, looking at retirement a few

2 months out. He said -- you know, he's gonna live

3 in Proctorsville, Vermont, for the rest of his

4 life, and he said he just didn't want to be

5 involved. Okay.

6 Q Okay. And did either Mr. Fowler or

7 Mr. Burns provide you with any information that

8 you relied on --

9 A None.

10 Q -- in drafting your opinions in this

11 case?

12 A None whatsoever.

13 Q And did they provide you any documents

14 or other information?

15 A None. Well, Brian Fowler gave me a

16 document related to --

17 You know, New Hampshire's symbol is the

18 old man in the mountain rock face.

19 Q Uh-huh.

20 A Well, it collapsed about ten years ago.

21 It's gone. And Brian Fowler's company did the

22 study that showed why the rock face collapsed.

23 And he gave me the paper about that. And that's

24 the only thing he gave me.

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1 Q Okay. And I take it that paper had

2 nothing to do with talc, this litigation.

3 A Absolutely. But he gave me something.

4 Q It was more of an interesting piece?

5 A Yeah. Very interesting.

6 Q Well, sir, thank you very much. That's

7 all the questions I have for right now. I'm

8 gonna yield my time at this point to my colleague

9 from Imerys, but I do reserve the right to come

10 back and ask a few questions if I find anything

11 in my notes.

12 A Sure.

13 Can I add something? I misspoke

14 earlier about Longo.

15 Q Okay.

16 A I had several copies of reports that he

17 did, and I -- I actually had, I want to say,

18 about 35 pages of that supplemental report that

19 summarized, you know, the percent samples that --

20 that had fibrous talc. And I did rely on that.

21 But I didn't have the full 2,000 pages in front

22 of me.

23 Q Okay.

24 A So I did -- I did use him some, but not

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1 in terms of trying to analyze what he did.

2 Q Okay. So is it fair to say your

3 reliance on the Longo testing is with respect to

4 the percentage of bottles that he found either

5 asbestiform -- well, what he characterized as

6 asbestiform minerals or fibrous talc?

7 A It went through his methodology, which

8 I thought was pretty interesting since he

9 actually began to apply numbers to some of the

10 data.

11 Q Uh-huh.

12 A Which was, I thought, an interesting

13 thing.

14 Q Okay. But I think we established

15 before you didn't do anything to check the

16 work --

17 A No, no.

18 Q -- or to analyze it.

19 A But I think I kind of implied I didn't

20 really look at it very much. But I -- I looked

21 at the first half, first part of his report of

22 the supplemental report.

23 Q All right. That's all the questions I

24 have for right now. We're gonna go off the

<p style="text-align: right;">Page 410</p> <p>1 record and I'll change seats with my colleague. 2 Thank you very much. 3 A Sure. 4 VIDEOGRAPHER: 5 Going off the record. The time is 6 5 p.m. 7 (OFF THE RECORD.) 8 VIDEOGRAPHER: 9 We're back on the record. The time is 10 5:01 p.m. 11 EXAMINATION 12 BY MR. FERGUSON: 13 Q Good afternoon, Dr. Cook. How are you? 14 A Fine. 15 Q We met briefly before the deposition 16 started. 17 A Yes. 18 Q My name is Ken Ferguson. Along with 19 Andrew Cary here to my right, we represent 20 Imerys. You understand that? 21 A Yes. 22 Q And I'm gonna ask you some questions 23 today regarding your testimony and your report. 24 Please make sure, as Mr. Frost told you, you</p>	<p style="text-align: right;">Page 412</p> <p>1 Q Let me ask you a few things 2 preliminarily. The one thing I noticed on your 3 CV is that you had a consultancy with Cyprus 4 Mines Corporation -- 5 A Yes. 6 Q -- at some point. Can you tell us when 7 that was? 8 A 1971 and '72. And this was as a 9 consultant through a firm that I worked for. 10 Q And what firm were you working for at 11 that time? 12 A Lindgren Exploration Company. 13 Q And could you tell us the general 14 nature of your consultancy with Cyprus Mines 15 Corporation? 16 A Exploration for massive sulfites, 17 looking for copper. 18 Q So it was an exploration stage rather 19 than a mining stage like you've been talking 20 about today? 21 A Yes. It was exploration. 22 Q And how long did that consultancy with 23 Cyprus Mines continue, more or less? 24 A It -- it was full-time pretty much for</p>
<p style="text-align: right;">Page 411</p> <p>1 understand what I'm asking before you answer, and 2 then let me know if you don't, and I'll restate 3 the question. Fair enough? 4 A Fair enough. 5 Q Okay. And one thing that I think 6 everybody gets in a little trouble with in this 7 process, particularly if they haven't been 8 through it much before, is talking before the 9 person finishes asking the question. 10 A All right. 11 Q Because we all do that in normal 12 conversation. So if you'd do your best to just 13 wait till I finish my question, and then -- and 14 then answer, and then I think we can -- we can go 15 a little bit smoother. Fair enough? 16 A Fair. 17 MS. O'DELL: 18 I would just add give me a millisecond 19 between the question and the answer, and I'll 20 have my opportunity to object if I need to. 21 THE WITNESS: 22 Okay. 23 MR. FERGUSON: 24 Fair enough.</p>	<p style="text-align: right;">Page 413</p> <p>1 a year and a half, and then it was part-time. 2 And then I came to Auburn and it continued a 3 little bit. 4 But Cyprus, they -- they acquired 5 property where I was working, but in the end they 6 handed it off to Kennecott Copper and, you know, 7 the end result was a failed project. We didn't 8 find anything. 9 Q Any other consultancies with Cyprus 10 Mines Corporation? 11 A Not -- not under that name. You know, 12 Cyprus was sold to FI- -- Freeport-McMoRan, 13 somebody like that. And there were Cyprus 14 employees that moved over to Freeport. But I 15 never did any more work for them, although I -- 16 you know, I was associated with their employees 17 even to this day. 18 Q And I take it you've never consulted 19 with Imerys? 20 A No. I have. 21 Q Okay. Tell me the nature of that 22 consultation. 23 A I -- I was a witness for them in a 24 sinkhole litigation at Sylacauga.</p>

<p style="text-align: right;">Page 414</p> <p>1 Q I'm sorry. At what?</p> <p>2 A Sylacauga. It's the name of a town</p> <p>3 where Imerys has three operating quarries. They</p> <p>4 make fine ground ultra-white carbonate for paper</p> <p>5 coating and other -- other things.</p> <p>6 Q And when was that?</p> <p>7 A It's been within the last ten years.</p> <p>8 It was a -- this was a relationship that was</p> <p>9 probably a year and a half long. I think I was</p> <p>10 deposed twice.</p> <p>11 Q And how about Luzenac? Any</p> <p>12 consultancies with Luzenac?</p> <p>13 A No.</p> <p>14 Q How about Rio Tinto Minerals?</p> <p>15 A No.</p> <p>16 Q Let me change gears a little bit and</p> <p>17 ask you about a couple things in your report.</p> <p>18 A Sure.</p> <p>19 Q And I'll tell you, I'm kind of</p> <p>20 prioritizing since I -- I have limited time. I'd</p> <p>21 like to finish up relatively quickly here. And,</p> <p>22 so, I may skip around a little bit. It's not to</p> <p>23 confuse you.</p> <p>24 A I understand.</p>	<p style="text-align: right;">Page 416</p> <p>1 I just want him to understand that</p> <p>2 there's not another document other than what he</p> <p>3 has marked as exhibit -- it's been marked as</p> <p>4 Exhibit 1 and 2, that that red-line is something</p> <p>5 that you -- you've created.</p> <p>6 MR. FERGUSON:</p> <p>7 Fair enough. Yes. And I didn't mean</p> <p>8 to imply otherwise. So, yes.</p> <p>9 Q I just wanted to see what change you</p> <p>10 made, and there are some computer programs you</p> <p>11 can do. I think we -- we all do them on</p> <p>12 occasion.</p> <p>13 So are you with me on page 11?</p> <p>14 A I am on page 11.</p> <p>15 Q All right. And you see there's a</p> <p>16 paragraph that starts "serpentine asbestos"?</p> <p>17 A Yes.</p> <p>18 Q Do you see that?</p> <p>19 A Yes.</p> <p>20 Q And, in that paragraph, about midway</p> <p>21 through, I guess four lines down, you say, "In</p> <p>22 1991, Dr. Alice Blount reported the presence of</p> <p>23 asbestos needles and fibers in Vermont talc which</p> <p>24 she later confirmed to be J&J baby powder."</p>
<p style="text-align: right;">Page 415</p> <p>1 Q So just make sure we're on the same</p> <p>2 page when you answer the questions. Fair enough?</p> <p>3 A Sure.</p> <p>4 Q And, also, I decided it would be smart</p> <p>5 to -- to copy or print your red-line version of</p> <p>6 your -- your report so I could see what changes</p> <p>7 you made, but it messed up the pagination. So if</p> <p>8 I get messed up there, you'll have to bear with</p> <p>9 me. Fair enough?</p> <p>10 A Fair.</p> <p>11 Q Can you go to page 11 of your report,</p> <p>12 please, sir?</p> <p>13 MS. O'DELL:</p> <p>14 What -- what red-line? Is that a</p> <p>15 red-line you created?</p> <p>16 MR. FERGUSON:</p> <p>17 No. It's your -- it's the red-line --</p> <p>18 yeah, yeah.</p> <p>19 MS. O'DELL:</p> <p>20 Because there was no red-lining --</p> <p>21 MR. FERGUSON:</p> <p>22 I understand. I just did a compare.</p> <p>23 That's all.</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 417</p> <p>1 And then you cite to Blount 1991 and</p> <p>2 her deposition. Is that correct?</p> <p>3 A Well, I think that it was -- what I've</p> <p>4 referenced there might have been an exhibit in</p> <p>5 Hopkins' deposition.</p> <p>6 Q Okay. Fair enough.</p> <p>7 And but you also, in your citation, say</p> <p>8 "Dep Alice Blount" --</p> <p>9 A Right.</p> <p>10 Q -- "Ph.D."</p> <p>11 A Right. I read her deposition.</p> <p>12 Q Okay.</p> <p>13 A She talked about it.</p> <p>14 Q All right. Now, did you read her 1991</p> <p>15 paper?</p> <p>16 A Yes, I did.</p> <p>17 Q And while you say in here that she</p> <p>18 later confirmed the presence of asbestos needles</p> <p>19 and fibers in what she later confirmed as J&J</p> <p>20 baby powder, there's no reference to J&J baby</p> <p>21 powder in her paper itself in 1991, is there?</p> <p>22 A I don't think so.</p> <p>23 Q And when you read her deposition --</p> <p>24 A I mean, I think she was very careful,</p>

<p style="text-align: right;">Page 418</p> <p>1 really, not to identify what she was working 2 with. I think she gave, you know, numerical or 3 letters to her samples. 4 MS. O'DELL: 5 In the paper? 6 THE WITNESS: 7 Right. 8 I think that she was trying to, you 9 know, shield the sources. 10 MR. FERGUSON: 11 Q Okay. But in the paper, 12 Johnson & Johnson baby powder was not identified? 13 A Correct. 14 Q And you say she later confirmed that a 15 sample was Johnson & Johnson baby powder. 16 Correct? 17 A Correct. 18 Q Now, I have marked as -- it was already 19 marked as Exhibit 3 -- a folder with your notes, 20 and I've taken the liberty -- I hope it's okay -- 21 A Sure. 22 Q -- marking each page. There's a 3.1, 23 3.2, so we can identify what we're talking about. 24 Fair enough?</p>	<p style="text-align: right;">Page 420</p> <p>1 Q And we're gonna go through these notes 2 in more detail later so -- so we can understand 3 what they are, but I just wanted to hit this 4 point early on. 5 If you'd pass that back to me if you're 6 done. 7 A Sure. 8 Q That's all I wanted to ask you. 9 And then I wanted to ask you about 3.5, 10 which I will pass to Miss O'Dell first. 11 MS. O'DELL: 12 Thank you. 13 MR. FERGUSON: 14 Q Now, again, is that another page of 15 your notes? 16 A Yes. 17 Q Okay. And, if you wouldn't mind, can 18 you hand it -- since we just got it today, I 19 didn't make copies of it. 20 A Sure. 21 Q Can you hand it to me and let me ask 22 you a question or two? 23 You have a notation after page 53 that 24 says "date confusion, 1996 purchase versus 1991</p>
<p style="text-align: right;">Page 419</p> <p>1 A Fair enough. 2 Q Okay. And let me show you what I've 3 marked as Exhibit 3.2. 4 MS. O'DELL: 5 Can you do a round robin so I can -- 6 MR. FERGUSON: 7 Yeah. If I find -- 8 MS. O'DELL: 9 -- so I can -- 10 MR. FERGUSON: 11 Sure. 12 A Okay. 13 MR. FERGUSON: 14 Q And there's a reference to Alice Blount 15 at the top of that page; correct? 16 A Yes. 17 Q And what -- what does that say? I just 18 want to make sure I know what it means. 19 A It says "Add Alice Blount." 20 Q And, then, what does that mean? 21 A It simply meant that I needed to 22 include her in my report. 23 Q I see. 24 A That's all.</p>	<p style="text-align: right;">Page 421</p> <p>1 paper. Sample I-J&J baby powder." 2 A Uh-huh. 3 Q Is that correct? Did I read that 4 correctly? 5 A Right. And I'm not sure that I wasn't 6 the one confused. But when I -- when I read -- 7 this was in her deposition. I believe these page 8 numbers refer to her deposition. And I think 9 that she corrected some information that she may 10 have misspoken. 11 Q But -- but you certainly, in reading 12 it, were confused about what she was talking 13 about; correct? 14 A Correct. 15 Q And you were confused about what she 16 was talking about with regard to the sample that 17 she was trying to identify; correct? 18 MS. O'DELL: 19 Object to the form. 20 A It was the dates. Only -- only the 21 dates. 22 MR. FERGUSON: 23 Q Okay. And you say in here 1991 versus 24 1996; correct?</p>

<p style="text-align: right;">Page 422</p> <p>1 A Correct.</p> <p>2 Q Okay. Did that have to do with when</p> <p>3 she acquired the sample?</p> <p>4 A I think that that had to do with the</p> <p>5 date that she mentioned in her deposition, which</p> <p>6 was incorrect. Now, that's from my memory.</p> <p>7 Q And, then, you've written another note</p> <p>8 by page 57. And what does that note say?</p> <p>9 A You're asking me to read my own</p> <p>10 writing?</p> <p>11 Q If you don't mind.</p> <p>12 A Okay.</p> <p>13 Q I can take a shot at it, but you may</p> <p>14 have a better shot.</p> <p>15 A It says "Confusion concerning sample</p> <p>16 IDs."</p> <p>17 And, again, it was -- it was me that</p> <p>18 was confused. I had to go back and reread what</p> <p>19 she was saying, and there were a couple of</p> <p>20 handwritten exhibits, I think, in her deposition</p> <p>21 that -- that I had to look at two or three times.</p> <p>22 Q And would you agree that there was some</p> <p>23 confusion about when she purchased the particular</p> <p>24 sample that she was referencing and she had</p>	<p style="text-align: right;">Page 424</p> <p>1 Q And -- and, so, I want to understand</p> <p>2 that testimony. I think you and Mr. Frost talked</p> <p>3 a bit about that. You're -- you're saying that,</p> <p>4 for example, Mr. Downey noted in his deposition</p> <p>5 that the talc is asbestos-free. Is that correct?</p> <p>6 A I think so.</p> <p>7 Q Let's look at a portion of his</p> <p>8 deposition together. And if you'd go to your</p> <p>9 left, I believe, is a white binder that says</p> <p>10 "Downey."</p> <p>11 A Yeah. Okay.</p> <p>12 Q You've got it?</p> <p>13 A Yeah. Sure.</p> <p>14 Q Okay. And -- and, if you would, turn</p> <p>15 to Mr. Downey's deposition.</p> <p>16 A Okay.</p> <p>17 MS. O'DELL:</p> <p>18 Ken, when you get to wherever you're</p> <p>19 going, let me know the number. I can get there,</p> <p>20 but it may take me just a second.</p> <p>21 MR. FERGUSON:</p> <p>22 Sure. Yep. Yep. I have that. I'm</p> <p>23 trying to identify the pages on the computer.</p> <p>24 Oh, there it is.</p>
<p style="text-align: right;">Page 423</p> <p>1 tested?</p> <p>2 A I don't think --</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I don't think she was confused. I</p> <p>6 think I was confused.</p> <p>7 MR. FERGUSON:</p> <p>8 Q Let's talk about another issue, which</p> <p>9 is -- can you go to your report at page 41?</p> <p>10 A Got it.</p> <p>11 Q In the -- the -- well, it's one of</p> <p>12 those where I can't tell you when. There's a</p> <p>13 heading called "Testing Methodologies For</p> <p>14 Asbestos Were Inadequate."</p> <p>15 Correct?</p> <p>16 A Yes.</p> <p>17 Q Okay. And in, I believe, the first</p> <p>18 paragraph, the last sentence, it says,</p> <p>19 "Regardless, the specification for cosmetic talc</p> <p>20 as indicated in the Hopkins, Downey, and Pier</p> <p>21 depositions of 2018 is that the talc is</p> <p>22 asbestos-free."</p> <p>23 Correct?</p> <p>24 A Yes.</p>	<p style="text-align: right;">Page 425</p> <p>1 Q Okay. So -- so if you look at page</p> <p>2 96 --</p> <p>3 A Okay.</p> <p>4 Q So you see at -- starting at line 17 --</p> <p>5 A Uh-huh.</p> <p>6 Q -- the question by, I believe,</p> <p>7 Miss O'Dell, it says: "And 'Imerys Talc</p> <p>8 America.' I'm just going to go ahead, since I've</p> <p>9 done that much. 'RTM and Luzenac America was/is</p> <p>10 responsible for ensuring that the talc sold to</p> <p>11 J&J was" -- since they're currently selling it --</p> <p>12 "is asbestos-free. Can we agree on that?"</p> <p>13 And then the answer, after an</p> <p>14 objection, is: "We test our product to ensure</p> <p>15 that it doesn't contain measurable asbestos, and</p> <p>16 that's what I can agree to."</p> <p>17 And that's what Mr. Downey answered.</p> <p>18 Correct?</p> <p>19 MS. O'DELL:</p> <p>20 Object to the form.</p> <p>21 A That's what he said here. I'm not sure</p> <p>22 this is the only point in his deposition that</p> <p>23 this topic appears.</p> <p>24 I would also like to add something to</p>

<p style="text-align: right;">Page 426</p> <p>1 that. The concept of measurable asbestos is an 2 interesting one. There's a way to preconcentrate 3 samples that gives you a lot bigger opportunity 4 to detect small amounts of asbestos. And this 5 was pointed out in the -- in the '70s by both 6 Pooley, Colorado School of Mines, and even, I 7 believe, Dartmouth. And this idea of 8 preconcentration -- 9 Oh, and Alice Blount even -- that was 10 what she used. It was completely rejected for 11 reasons unknown. And it would have -- it would 12 have allowed a much lower detection limit. 13 And, so, it's easy to say, you know, 14 well, we didn't really detect any. But he could 15 have added but we might have if we'd used a 16 preconcentration technique, as recommended. So, 17 you know, I'm not sure what -- what he really 18 might have been meaning there. 19 Q Okay. Well, but you don't know what he 20 meant, but we can read what his testimony was, as 21 we did; correct? 22 MS. O'DELL: 23 Object to the form. 24 A And we did.</p>	<p style="text-align: right;">Page 428</p> <p>1 asbestos-free, and we've been, you know, in this 2 room together for a few hours and, you know, 3 even, say, that the air in this room is 4 asbestos-free. So I can't really agree with the 5 way that you've written that." 6 Did I read that correctly? 7 A Yeah. 8 Q Okay. And certainly based on the 9 answers that we read -- 10 And I'm not gonna sit here and read the 11 whole deposition, and you wouldn't want me to. 12 A Yeah. That's a problem. 13 Q But in terms of what we've read, he did 14 not say that the policy was asbestos-free. He 15 explained in his answers what his -- what the 16 policy was or his philosophy of the policy. 17 MS. O'DELL: 18 Object to the form. 19 MR. FERGUSON: 20 Q Correct, sir? 21 A I think on the two pages we looked at 22 out of a deposition that's, what, 5- or 600 pages 23 long. 24 Q Can you cite me to the portion --</p>
<p style="text-align: right;">Page 427</p> <p>1 MR. FERGUSON: 2 Q Okay. Why don't you go to page 97. 3 Let's read one more question and answer. 4 A Okay. 5 Q At page 97, starting at line 20 -- 6 A Okay. 7 Q -- by Miss O'Dell: "Is that fair? 8 Because you wouldn't agree it's not -- you won't 9 agree it's asbestos-free. You agree that it's 10 below detectable limits; true?" 11 And then Mr. Downey's answer is -- is a 12 little long, so just follow it along with me. He 13 says, on page 98: "Our talc, we have a rigorous 14 testing program that also includes not only the 15 testing itself but our knowledge of the ore 16 deposits and the testing that and sampling and 17 mapping that we do continually through the 18 process. We are confident that our products are 19 safe, but in terms of a detection limit, I'm not 20 the expert on that. Julie Pier can speak to 21 that. But the scientific instruments are not 22 available to tell us that our product is, quote, 23 unquote, asbestos-free. We can't say that in 24 this room that has air in this room is</p>	<p style="text-align: right;">Page 429</p> <p>1 A No. 2 Q -- in which Mr. Downey said what you 3 said he said, which is that the policy is 4 asbestos-free? 5 A No. 6 MS. O'DELL: 7 Object to the form. 8 MR. FERGUSON: 9 Q Okay. You can -- you can put that 10 away. I think we're through with Mr. Downey for 11 the time being. 12 A Okay. 13 Q Just go ahead and set that to your 14 left, because I know it's a big volume. 15 MS. O'DELL: 16 Don't let it go far. I'll take it. 17 MR. FROST: 18 You there, Leigh? 19 MS. O'DELL: 20 Yeah, I've got it. I'm good. 21 MR. FERGUSON: 22 You good? 23 MS. O'DELL: 24 Yeah. I'm good. Barely.</p>

<p style="text-align: right;">Page 430</p> <p>1 MR. FERGUSON: 2 Barely? 3 MS. O'DELL: 4 Barely. 5 MR. FERGUSON: 6 You ready for us to go, Leigh? 7 MS. O'DELL: 8 Yeah, yeah. 9 MR. FERGUSON: 10 Q Dr. Cook, as you and Mr. Frost talked 11 about, you've published a number of peer-reviewed 12 academic papers; correct? 13 A Correct. 14 Q Is it fair to say that customarily you 15 cite peer-reviewed research in your academic 16 papers? 17 A It's not the only thing you cite, but, 18 sure, that's fair enough. 19 Q Okay. And -- and in your academic 20 papers, would it be fair to say that you 21 generally do not cite to paid experts for a 22 particular party with an interest in the 23 litigation? 24 MS. O'DELL:</p>	<p style="text-align: right;">Page 432</p> <p>1 Object to the form. 2 A I thought that you asked about 3 peer-reviewed publications. I've not cited Longo 4 in a peer-reviewed publication. The only place 5 I've ever mentioned him is in my expert report. 6 I guarantee it won't be published. 7 MR. FERGUSON: 8 Q In your report on a number of 9 occasions, you refer to contemporaneous testing 10 that shows the presence of -- of certain 11 contaminants in Johnson & Johnson's baby powder. 12 Correct? 13 A "Contemporaneous testing." 14 Q Yes, sir. 15 A I mean, is that your word or my word? 16 Q That's your word. 17 A Okay. 18 Q When you refer to contemporaneous 19 testing, are you referring to -- to Dr. Longo's 20 report? 21 A No. 22 Q Okay. What are you referring to? 23 A No. I think contemporaneous testing 24 means that you're -- you're testing in a -- in a</p>
<p style="text-align: right;">Page 431</p> <p>1 Object to the form. 2 A I would hope not to do that. 3 MR. FERGUSON: 4 Q Okay. So in your academic papers, you 5 would not cite to a non-peer-reviewed publication 6 that is authored by a litigation expert who was 7 hired by a particular side in litigation; 8 correct? 9 MS. O'DELL: 10 Object to the form. 11 A If I did, it would not be on purpose. 12 MR. FERGUSON: 13 Q But in your report here, that's exactly 14 what you did do; correct? 15 A I don't know. 16 Q Did you cite to Mr. -- Dr. Longo's 17 report? 18 A Oh, I had to. Of course. I mean, I'm 19 not sure that I understand why there's a problem 20 with that. 21 Q But that is different than what you do 22 in your academic papers. 23 A Well, but you -- 24 MS. O'DELL:</p>	<p style="text-align: right;">Page 433</p> <p>1 timely manner relative to the processes that are 2 in place. For instance, if you're gonna -- if 3 you're gonna test the drill cuttings that are 4 generated by your blast hole driller, then you 5 need to go ahead and analyze those. It makes no 6 sense to wait for a year after the blast has been 7 made and another blast and another blast and then 8 analyze them. That would not be contemporaneous 9 testing. And that's all I'm saying. You need to 10 be testing as you move forward in the milling and 11 mining process so that you know what the 12 character of the material is at the time that 13 you're producing it, not a year or ten years 14 later. 15 Q And you and Mr. Frost talked toward the 16 end of your questioning about the extent to which 17 you relied or didn't rely on Dr. Longo's testing. 18 Do you recall that conversation? 19 A Yes. 20 Q Okay. And I'm not gonna go back 21 through that. 22 A I mean, I've referenced him. And 23 that -- that was why I said I'd like to say a 24 little -- a little bit more about Longo.</p>

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1 Because, you know, he has more than one report.
 2 Q Now, Dr. Longo's reports relate to
 3 whether there is or is not asbestos in baby
 4 powder; correct?
 5 A And fibrous talc.
 6 Q Okay. Now, are you aware that the
 7 U.S. Food and Drug Administration actually tested
 8 a number of body powder products and raw material
 9 talc about ten years ago to determine if, in
 10 fact, there was asbestos detected in that -- that
 11 product or those products?
 12 A I'm --
 13 MS. O'DELL:
 14 Object to the form.
 15 A I'm familiar with the report. And at
 16 the end of the report, it says that these results
 17 are not to be taken to mean there's no asbestos
 18 in these products.
 19 MR. FERGUSON:
 20 Q With regard to the findings of that
 21 report, do you know that -- that both
 22 Johnson & Johnson and Imerys supplied product to
 23 be tested by the FDA?
 24 A Yes.

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1 Q Correct?
 2 MS. O'DELL:
 3 Object to the form. That's a
 4 misstatement as to Johnson & Johnson, as you're
 5 aware.
 6 MR. FERGUSON:
 7 Let me go back.
 8 MS. O'DELL:
 9 In terms of supplying it. They
 10 purchased it, but Johnson & Johnson did not
 11 supply.
 12 MR. FERGUSON:
 13 My -- my bad language. Okay?
 14 Q Do you understand that the FDA did, in
 15 fact, test a Johnson & Johnson baby powder
 16 product?
 17 A Correct.
 18 Q And they also tested some cosmetic raw
 19 material talc supplied by Luzenac; correct?
 20 A I think that's right.
 21 MS. O'DELL:
 22 Rio Tinto.
 23 MR. FERGUSON:
 24 Luzenac/Rio Tinto, I think it says.

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1 MS. O'DELL:
 2 Fair enough.
 3 MR. FERGUSON:
 4 Trying to save time there.
 5 MS. O'DELL:
 6 Okay. Well, I'm just being clear.
 7 MR. FERGUSON:
 8 Fair enough. So we'll start over so I
 9 say that -- say that technically correct.
 10 Q You are aware, then, that a raw --
 11 cosmetic raw material talc that was supplied by
 12 Rio Tinto Mineral/Luzenac America in eight
 13 separate lots was supplied to the FDA for
 14 testing?
 15 A I don't know about the eight separate
 16 lots.
 17 Q Okay.
 18 A I don't remember that.
 19 Q You know they supplied some.
 20 A Yes.
 21 Q And that there was no asbestos
 22 detected; correct?
 23 A Correct.
 24 Q And that there was no asbestos --

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1 A With some methods employed.
 2 Q Of course. With the methods they
 3 employed, the U.S. Food and Drug Administration,
 4 there was no asbestos detected in the
 5 Johnson & Johnson baby powder product that they
 6 had obtained. Correct?
 7 A Right.
 8 MS. O'DELL:
 9 Object to the form.
 10 A Yes.
 11 MR. FERGUSON:
 12 Q And is it also true that they obtained
 13 a Johnson & Johnson Shower to Shower product as
 14 well?
 15 A I believe that's correct.
 16 Q Okay. And, likewise, did they find
 17 that the Shower to Shower product had no asbestos
 18 detected by the methods they utilized?
 19 A I think that's correct.
 20 Q Let's talk a little bit about the other
 21 substances that you have talked about today,
 22 including the so-called heavy metals. First of
 23 all, let me talk to you about arsenic.
 24 A Okay.

<p style="text-align: right;">Page 438</p> <p>1 Q You've discussed arsenic today;</p> <p>2 correct?</p> <p>3 A Correct.</p> <p>4 Q Would you agree that the general</p> <p>5 population is exposed to arsenic through --</p> <p>6 through various modes?</p> <p>7 A Oh, I think so.</p> <p>8 Q Arsenic is actually transported in the</p> <p>9 environment by water; correct?</p> <p>10 MS. O'DELL:</p> <p>11 Object to the form.</p> <p>12 A Yes. And -- and the -- the -- the</p> <p>13 limits on arsenic in water has -- has lowered</p> <p>14 dramatically.</p> <p>15 MR. FERGUSON:</p> <p>16 Q And -- and arsenic is found in drinking</p> <p>17 water in many places, including in the</p> <p>18 United States, correct, at some level?</p> <p>19 A I think that at some level, yes. I</p> <p>20 think that you're looking at the low parts per</p> <p>21 billion is -- is, you know, where you'd better</p> <p>22 be. If you're in the parts per million, you're</p> <p>23 gonna -- you know, you're out of spec. You're in</p> <p>24 trouble.</p>	<p style="text-align: right;">Page 440</p> <p>1 Object to the form.</p> <p>2 A I don't know. But if you tell me that,</p> <p>3 I would accept it.</p> <p>4 MR. FERGUSON:</p> <p>5 Q Okay. I could refer you to IARC page</p> <p>6 175.</p> <p>7 A Okay.</p> <p>8 Q I'll tell you IARC says that.</p> <p>9 A Okay.</p> <p>10 Q You're not arguing with IARC on that</p> <p>11 point, are you?</p> <p>12 A Nope.</p> <p>13 Q Okay. And nickel's found in food and</p> <p>14 drinking water; correct?</p> <p>15 A Yes.</p> <p>16 Q And, then, chromium was another</p> <p>17 substance you talked about; correct?</p> <p>18 A Correct.</p> <p>19 Q The general population can be exposed</p> <p>20 to chromium through inhalation of ambient air or</p> <p>21 ingestion; correct?</p> <p>22 A Correct.</p> <p>23 Q Now, you've talked about each of these</p> <p>24 substances, nickel, chromium, arsenic, and said</p>
<p style="text-align: right;">Page 439</p> <p>1 Q Would you agree that many foods even</p> <p>2 contain arsenic?</p> <p>3 A Yes.</p> <p>4 Q And that particularly the highest</p> <p>5 concentrations of food -- of arsenic in food are</p> <p>6 in seafood?</p> <p>7 A I don't know that that's true. I know</p> <p>8 that it's true for probably mercury, but I'm</p> <p>9 not -- I'm not sure about arsenic. But I could</p> <p>10 certainly see how arsenic could -- could get into</p> <p>11 seafood.</p> <p>12 Q Did you read the 2012 publication</p> <p>13 monograph by IARC on arsenic metals, fibers, and</p> <p>14 dusts?</p> <p>15 A If I read that section, I read it</p> <p>16 really early on in the process of going through</p> <p>17 all the materials that I was supplied.</p> <p>18 Q Let's talk about another substance that</p> <p>19 you've talked about some, which is nickel. Do</p> <p>20 you recall discussing nickel today?</p> <p>21 A Sure.</p> <p>22 Q And nickel, in fact, is the 24th most</p> <p>23 abundant element; correct?</p> <p>24 MS. O'DELL:</p>	<p style="text-align: right;">Page 441</p> <p>1 that -- I'm trying to figure out where -- you</p> <p>2 said these are known carcinogens, I believe, in</p> <p>3 each instance. Is that correct?</p> <p>4 MS. O'DELL:</p> <p>5 Object to the form.</p> <p>6 MR. FERGUSON:</p> <p>7 Q In your report.</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A Yes. You did not include cobalt;</p> <p>11 right?</p> <p>12 MR. FERGUSON:</p> <p>13 Q I did not include cobalt.</p> <p>14 A Okay. Right, then.</p> <p>15 Q Is that correct?</p> <p>16 A I think so.</p> <p>17 Q So nickel, chromium, arsenic you have</p> <p>18 said are known carcinogens; correct?</p> <p>19 A I believe they are.</p> <p>20 Q Now, and I realize you are not an</p> <p>21 expert on toxicology --</p> <p>22 A Correct.</p> <p>23 Q -- or carcinogenicity or medicine;</p> <p>24 correct?</p>

<p style="text-align: right;">Page 442</p> <p>1 A Correct.</p> <p>2 Q But in your report you said these are</p> <p>3 known carcinogens; correct? Is that based on --</p> <p>4 A Well, I think they're spelled out in</p> <p>5 IARC that they are.</p> <p>6 Q Now, with regard to IARC, with regard</p> <p>7 to -- and we'll take them separately. With</p> <p>8 regard to nickel, is there any statement in IARC</p> <p>9 indicating that nickel is in any way associated</p> <p>10 with ovarian cancer?</p> <p>11 MS. O'DELL:</p> <p>12 Object to the form.</p> <p>13 A I did not read anything to that effect.</p> <p>14 MR. FERGUSON:</p> <p>15 Q Okay. And with regard to chromium, is</p> <p>16 there any indication in the IARC report in 2012</p> <p>17 that chromium is in any way associated with</p> <p>18 ovarian cancer?</p> <p>19 MS. O'DELL:</p> <p>20 Object to the form.</p> <p>21 A Again, I didn't read anything that</p> <p>22 would indicate that.</p> <p>23 MR. FERGUSON:</p> <p>24 Q And, likewise, arsenic, is there any</p>	<p style="text-align: right;">Page 444</p> <p>1 Would you agree with me that asbestos minerals</p> <p>2 are widespread in the environment?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A Asbestos minerals? Yes. In terms of</p> <p>6 the amphiboles with respect to chrysotile,</p> <p>7 probably it's -- it's more limited in occurrence.</p> <p>8 MR. FERGUSON:</p> <p>9 Q And why don't -- why don't we go ahead</p> <p>10 and just refer, in case we need to, to the IARC</p> <p>11 2012 monograph.</p> <p>12 I -- I set it over there to his left,</p> <p>13 Leigh. I believe it's the one right there, if I</p> <p>14 recall correctly.</p> <p>15 A Okay.</p> <p>16 Q Can you, first of all, turn to the</p> <p>17 monograph itself, which I think is the first item</p> <p>18 in there?</p> <p>19 A It is.</p> <p>20 Q Okay. And would you go to page 222?</p> <p>21 A I'm getting there. Okay. I've got it.</p> <p>22 Q Are you there, 222?</p> <p>23 A Right. Uh-huh.</p> <p>24 Q Under "Natural Occurrence" --</p>
<p style="text-align: right;">Page 443</p> <p>1 indication in the IARC report that arsenic is in</p> <p>2 any way associated with ovarian cancer?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I didn't read anything like that.</p> <p>6 MR. FERGUSON:</p> <p>7 Q And you understand that -- that the</p> <p>8 litigation that we're here today about deals with</p> <p>9 ovarian cancer; correct?</p> <p>10 A I -- I understand that.</p> <p>11 Q You're welcome to look at it, but I'll</p> <p>12 represent to you on pages 5 to 6 of your report</p> <p>13 you -- you have a quote that says, "Hand sorting</p> <p>14 at the Chinese mine is used as a first step in</p> <p>15 the beneficiation process."</p> <p>16 Do you recall generally making that</p> <p>17 comment?</p> <p>18 A Sure. Of course.</p> <p>19 Q Well, we can look it up if you want.</p> <p>20 A No. I remember writing it. It's true.</p> <p>21 Q Okay. Are you critical of hand sorting</p> <p>22 as a first step in the beneficiation process?</p> <p>23 A No.</p> <p>24 Q Let's talk a little bit about asbestos.</p>	<p style="text-align: right;">Page 445</p> <p>1 A Uh-huh.</p> <p>2 Q Do you see that section? And there's</p> <p>3 the sentence I just quoted, "Asbestos minerals</p> <p>4 are widespread in the environment and are found</p> <p>5 in many areas where the original rock mass has</p> <p>6 undergone metamorphism."</p> <p>7 Correct?</p> <p>8 A Correct.</p> <p>9 Q And further they go on in IARC to say</p> <p>10 that asbestos minerals are found in the water,</p> <p>11 soil, and air.</p> <p>12 Is that accurate?</p> <p>13 MS. O'DELL:</p> <p>14 In terms of what it states or --</p> <p>15 MR. FERGUSON:</p> <p>16 Q Yeah.</p> <p>17 A Air monitoring for asbestos is -- was a</p> <p>18 major industry. So with respect to air,</p> <p>19 certainly. Soil, certainly. There's been lots</p> <p>20 of work done on that. Water, I don't -- I don't</p> <p>21 have a knowledge base relative to water with</p> <p>22 respect to asbestos. I'm sure you can find it in</p> <p>23 some waters. I'm not sure that -- that these</p> <p>24 waters aren't gonna be directly related to some</p>

<p style="text-align: right;">Page 446</p> <p>1 peculiar industrial application, such as maybe 2 outside of an insulation factory, something like 3 that you might find surface water that has a 4 little asbestos in it. 5 Q Take a look at page 224. 6 A Okay. Okay. Got it. 7 Q You see there's a section on water? 8 A I see it. 9 Q It says, "Asbestos can enter the 10 aquatic environment from both natural and 11 anthropogenic sources." 12 A Sure. 13 Q And has been measured in both ground 14 and surface water samples; correct? 15 A Yes. 16 MS. O'DELL: 17 Would you mind finishing the paragraph? 18 MR. FERGUSON: 19 Oh, I'm happy -- I'm happy to read the 20 whole paragraph. I don't want to read the whole 21 thing. But it says, "Erosion of asbestos-bearing 22 rock is the principal natural source. 23 Anthropogenic sources include erosion of waste 24 piles containing asbestos, erosion of asbestos</p>	<p style="text-align: right;">Page 448</p> <p>1 Q Cubic meter. My bad. I know three is 2 a cubic. 3 A Yep. 4 Q Is that correct? 5 A Correct. 6 Q Okay. And do you take issue with that? 7 I know -- 8 A No. 9 Q And then it goes on to say in that 10 paragraph, "Typical concentrations are about 11 tenfold higher in urban locations and about 1,000 12 times higher in close proximity to industrial 13 sources of exposure, asbestos mine or factory, 14 demolition site or improperly protected 15 asbestos-containing waste site." 16 That's what IARC says; correct? 17 A I think there's lots of data on that. 18 Q Sorry? 19 A I think there's a lot of data on that 20 that would suggest that that's a correct 21 statement. 22 Q And just a couple more here. In the 23 next paragraph, it says, "In indoor air -- e.g., 24 in homes, schools, and other buildings --</p>
<p style="text-align: right;">Page 447</p> <p>1 cement pipes, disintegration of 2 asbestos-containing roofing materials and 3 industrial wastewater runoff." 4 MS. O'DELL: 5 Okay. 6 MR. FERGUSON: 7 Q Why don't you go to page 225. 8 A Okay. 9 Q And you see there's a section called 10 "Exposure of the General Population"? 11 A Yes. 12 Q And the first sentence there says, 13 "Inhalation of asbestos fibers from outdoor air 14 and, to a lesser degree, an indoor air is the 15 primary route of exposure for the nonsmoking 16 general population." 17 Correct? 18 A Correct. 19 Q If you look in the next paragraph, the 20 second sentence says that low levels of asbestos 21 have been measured in outdoor air in rural 22 locations. Typical concentration, 10 fibers per 23 square meter. Correct? 24 A Cubic meter.</p>	<p style="text-align: right;">Page 449</p> <p>1 measured concentrations of asbestos are in the 2 range of 30 to 6,000 fibers per cubic meter." 3 Correct? 4 A Correct. 5 Q So the bottom line is there is a level 6 of background exposure to asbestos for the 7 general population. Correct? 8 MS. O'DELL: 9 Object to the form. 10 A I think it's a correct statement. 11 MR. FERGUSON: 12 Q I'm sorry? 13 A I think that's a correct statement. 14 Q I want to talk to you a little bit 15 about your notes that we made reference to 16 earlier. Just -- I'm not gonna have you read 17 them into the record. 18 A Okay. 19 Q Thankfully. 20 A Yeah. 21 Q But I just had a few questions on 22 the -- what I'll hand to you as 3.1. You have 23 the letter K in the upper left-hand corner, and 24 then it says "Page 4, Italian-mined ultramafic</p>

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1 origin" with two question marks. Okay? And
 2 we'll let Miss O'Dell take a look at it, and then
 3 I'll ask you what is meant by that.
 4 A Sure. Not a problem.
 5 Q Okay. I'm --
 6 A I wish I had put dates on these.
 7 Q I'm assuming that that is a reference
 8 to Dr. Krekeler's report. Is that correct?
 9 A I think it is.
 10 Q Okay.
 11 A I can tell you what -- what the note
 12 means.
 13 Q All right.
 14 A There -- there are ophiolites
 15 associated with the mountain-building process
 16 that produced the Alps. And, so, ophiolites are
 17 ultramafic. So you could have had talc
 18 occurrences that were similar to those in Vermont
 19 or you could have had the Val Chisone type, which
 20 we know are actually related, to metamorph those
 21 carbonate rocks. And I -- I was making really a
 22 note to myself to go back and take a hard look at
 23 the Italian talc occurrences and make darn sure
 24 that there are no ultramafic rocks associated

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1 with Val Chisone.
 2 Q Okay.
 3 A And that's all that means.
 4 Q Could I have that back --
 5 A Sure.
 6 Q -- please?
 7 A You bet.
 8 Q Are there any ultramafic rocks in
 9 Val Chisone?
 10 A They are not shown in the immediate
 11 proximity to those talc deposits.
 12 Q Okay.
 13 A If they're there, you don't see them on
 14 the map of the deposits.
 15 Q So you're not aware that they're there.
 16 You don't see --
 17 A I don't think that the talc deposits
 18 are related to ultramafic rocks.
 19 Q I'm sure all this will be very
 20 interesting, but I'm not going to take the time
 21 to go through each of these.
 22 Let me show you 3.6.
 23 MS. O'DELL:
 24 Thank you.

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1 A Sorry about that.
 2 MR. FERGUSON:
 3 Q And my question to you is --
 4 And feel free to look at -- take your
 5 time to look at it if you need to.
 6 At the top, it says, "For expert report
 7 12-29-18." What does that mean? Does that mean
 8 it's -- well, you tell me what that means. Notes
 9 for your expert report?
 10 A I turned in my -- the first version of
 11 my expert report prior to this date. And then
 12 these are notes about things that need to be
 13 added since I'm getting the material.
 14 Q Okay. Fair enough.
 15 Then 3.8, I'm just trying to figure out
 16 generally what that is.
 17 A Sure.
 18 Q You don't have to fill me in on all the
 19 details but I'm trying to understand what the
 20 purpose of that document is.
 21 A Sure.
 22 Oh, this is something that I did very
 23 early on. When I first was asked by Miss O'Dell
 24 to look at this, one of the things I did was to

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1 try to track possible talc sources. I wasn't
 2 aware of -- I mean, I knew that there was Montana
 3 talc being mined. I didn't know at this point
 4 whether or not Montana talc was being used as a
 5 cosmetic product, for example.
 6 So this is -- this is just a page where
 7 I was jotting down some notes about where talc
 8 had been mined in the US. That's it.
 9 Q Thank you.
 10 A Sure.
 11 Q And then there's several pages that I
 12 think seem obvious that you had a Downey depo.
 13 Then you have notes --
 14 A Right.
 15 Q -- out beside page whatever.
 16 A Sure.
 17 Q So you've made notes on various
 18 depositions; correct?
 19 A Yes.
 20 Q Did you read a transcript of a trial
 21 called Herford?
 22 A I don't remember it.
 23 Q Okay. Or depositions from the Herford
 24 case?

<p style="text-align: right;">Page 454</p> <p>1 A What would be a -- a name, a person's 2 name that would be deposed? 3 Q I can't tell you. 4 A I mean, the -- I think I've actually 5 seen the Herford name, but I don't -- I don't 6 know that I've seen a deposition or a transcript. 7 Q Let me show you 3.9. Just let me know 8 what that is. I'm trying to figure out what it 9 is you summarized there. 10 A Okay. 11 MS. O'DELL: 12 And you're just talking to -- about 13 this here? Because there appears to be -- 14 MR. FERGUSON: 15 There are a number of things in there. 16 MS. O'DELL: 17 That the Hicks deposition's reference, 18 which, of course, would have been in this case, 19 and some other? 20 MR. FERGUSON: 21 Right. Yeah. 22 Q The Herford notation, what is that? 23 MS. O'DELL: 24 Right in the center of that page.</p>	<p style="text-align: right;">Page 456</p> <p>1 Would you describe for us the 2 methodology that you've used in reaching your 3 opinions in this case? 4 A Okay. When -- when -- when you first 5 approached me and we discussed the -- the data 6 sets that you thought would be available and, you 7 know, did I understand mining techniques that 8 might be related to what we were doing and did I 9 understand the milling processes, did I 10 understand the -- the methodology in testing, you 11 know, I answered affirmatively. So you began to 12 supply me with documents. 13 But based on your original description 14 of the project, I started doing my own background 15 literature review. And, so, I began to weed that 16 literature review, the knowledge I had with that 17 review, in with information that I already had in 18 my head relative to talc and asbestos and heavy 19 metals and the mining. Anyway, I began to 20 develop a database from which I worked. 21 And, so, as you began to give me 22 information, I began to categorize it based on 23 the type of information. Is it asbestos sources? 24 Is it mining? In other words, what does that --</p>
<p style="text-align: right;">Page 455</p> <p>1 A Uh-huh. I don't know. I apparently 2 didn't use it at all. When I read the 3 deposition, apparently Hicks mentioned this on 4 page 102, and I made a note to that effect. 5 I see here that it has x-ray refraction 6 mentioned. But I don't -- I don't know. I 7 didn't refer to this. I mean, I don't think I 8 referred to it in my report. 9 Q Dr. Cook, I think that's all I have. 10 Thank you -- thank you for your time, sir. 11 A Okay. You're welcome. 12 MS. O'DELL: 13 Let's go off the record. 14 VIDEOGRAPHER: 15 Going off the record. The time is 5:46 16 p.m. 17 (OFF THE RECORD.) 18 VIDEOGRAPHER: 19 We're back on the record. The time is 20 6:21 p.m. 21 EXAMINATION 22 BY MS. O'DELL: 23 Q Dr. Cook, I have a few questions for 24 you.</p>	<p style="text-align: right;">Page 457</p> <p>1 that document pertain to? 2 And, in the end, I ended up with maybe 3 six or eight headings that -- that I thought I 4 could categorize information in. 5 And, so, I began to look -- to look at 6 the material that I had put in each category and 7 see if there were trends that were beginning to 8 come out of the -- out of these data sets. 9 And, of course, in some, there were. 10 And, so, I began to take notes, and those notes 11 were in the form originally of -- of a simple 12 outline of headings with statements. And from 13 that outline and those statements, those 14 statements became paragraphs as more information 15 was gained, and ultimately a report came out of 16 that. 17 And, so, I -- I approached it as I 18 would any research project, except that I wasn't 19 generating new data. I was evaluating existing 20 data. And -- and that's an accepted technique in 21 terms of using the scientific method to come to a 22 conclusion or an opinion. 23 And, so, you know, ultimately, you see 24 these documents here. They're about maybe 650</p>

<p style="text-align: right;">Page 458</p> <p>1 documents here, and this is not half of the</p> <p>2 documents that I've reviewed so far. And --</p> <p>3 and -- and I hope to continue reviewing documents</p> <p>4 that will then add to the database from which my</p> <p>5 opinions will be supported.</p> <p>6 Q Why did you -- you cited some geologic</p> <p>7 references in articles. I think one of them was</p> <p>8 Van Gosen. I think you were asked about</p> <p>9 Chidester earlier today, as well as some</p> <p>10 references that related to not only Vermont talc</p> <p>11 deposits but also Italian talc. What was the</p> <p>12 purpose of citing those references?</p> <p>13 MR. FROST:</p> <p>14 Objection to form.</p> <p>15 A Yeah. Well, the Vermont papers had to</p> <p>16 do with setting the stage for the geologic</p> <p>17 framework within which the ultramafic rocks</p> <p>18 occurred. So they weren't intended to point out</p> <p>19 any character events, any specific mine. It was</p> <p>20 to -- to give the interested reader some way to</p> <p>21 gain background information.</p> <p>22 And the same is really true about the</p> <p>23 Italian talc deposits. I -- I gave those</p> <p>24 references that are really general geologic</p>	<p style="text-align: right;">Page 460</p> <p>1 Dr. Cook?</p> <p>2 MR. FROST:</p> <p>3 Oh, yes. Absolutely. That's fine.</p> <p>4 MS. O'DELL:</p> <p>5 Q And you'll see -- I believe it's on</p> <p>6 page 993, but that's where the --</p> <p>7 A Right.</p> <p>8 Q -- Vermont description occurs.</p> <p>9 A Sure.</p> <p>10 Q Would that description of the Vermont</p> <p>11 talc deposits be relevant and applicable to the</p> <p>12 Vermont mines that were used to source</p> <p>13 Johnson & Johnson's talcum powder products?</p> <p>14 A Sure. It's a -- it's a brief</p> <p>15 description of the -- the talc district as a</p> <p>16 whole, and from that you can begin to -- to put</p> <p>17 individual deposits. But this is just a -- a</p> <p>18 general background paper.</p> <p>19 Q Okay. In the methodology, have you --</p> <p>20 you've described, is that methodology you've used</p> <p>21 at other points in -- in your career?</p> <p>22 MR. FROST:</p> <p>23 Objection to form.</p> <p>24 A Yes. And, in fact, that's -- that's</p>
<p style="text-align: right;">Page 459</p> <p>1 information so that there was a foundation upon</p> <p>2 which the more detailed information could be --</p> <p>3 be anchored.</p> <p>4 Q Uh-huh. Would it have been -- would it</p> <p>5 be your normal practice as a professional</p> <p>6 geologist as well as a professor to refer to and</p> <p>7 cite general geological references when</p> <p>8 describing a specific deposit?</p> <p>9 A Yes. That's -- that's the start of</p> <p>10 the -- if it's gonna be a paper, that's the start</p> <p>11 of a -- of a paper that might be submitted for</p> <p>12 publication. You don't want to start and assume</p> <p>13 that the reader knows more than he may know. You</p> <p>14 need to give the reader the opportunity to start</p> <p>15 at a relatively low general point.</p> <p>16 Q You were provided a copy that was</p> <p>17 marked as an exhibit -- I think it was Exhibit</p> <p>18 11. Was -- was actually the Van Gosen paper.</p> <p>19 A Okay.</p> <p>20 Q And specifically in the Van Gosen</p> <p>21 paper, I think it goes into Vermont talc deposits</p> <p>22 on page 933.</p> <p>23 And, Jack, I have it marked on mine.</p> <p>24 Do you mind, just for ease, if hand it to</p>	<p style="text-align: right;">Page 461</p> <p>1 the standard method of operation. You're</p> <p>2 presented with a problem. I go to the library</p> <p>3 and -- and get all the material I can get and</p> <p>4 read up on it. And, then, in the case of the</p> <p>5 talc litigation here, you -- you have to treat</p> <p>6 the documents that you're being given as data.</p> <p>7 And the data you use as you would in any</p> <p>8 scientific investigation. You use it to either</p> <p>9 confirm a hypothesis or disprove it. And if you</p> <p>10 disprove it, you modify the hypothesis and -- and</p> <p>11 work on it again. And, so, and that's exactly</p> <p>12 what I did here.</p> <p>13 Q And, in doing that, did you use the</p> <p>14 same attention to detail that you would use in</p> <p>15 your duties previously as a professor of geology?</p> <p>16 MR. FROST:</p> <p>17 Objection to form.</p> <p>18 A Yes. In fact, the attention to detail</p> <p>19 is almost overwhelming. There's a lot of -- a</p> <p>20 lot of detail here.</p> <p>21 MS. O'DELL:</p> <p>22 Q And would it also be the same type of</p> <p>23 methodology that you would use in your duties</p> <p>24 consulting for companies as a professional</p>

<p style="text-align: right;">Page 462</p> <p>1 geologist?</p> <p>2 MR. FROST:</p> <p>3 Objection.</p> <p>4 A Yes, in fact, I've done scoping studies</p> <p>5 for Kinross and one other company within the last</p> <p>6 few years. And this is pretty much what they --</p> <p>7 what they're looking for is a -- a compilation of</p> <p>8 all information available on a particular topic</p> <p>9 or area put together in a report. And the</p> <p>10 working hypothesis for a mining company is, in</p> <p>11 this area, given all the data that's available to</p> <p>12 you, would you recommend coming in and spending a</p> <p>13 million bucks looking for a new mineral deposit?</p> <p>14 And, so, from that standpoint, it's</p> <p>15 exactly what -- what I did here. I mean, it's</p> <p>16 the same general intellectual exercise.</p> <p>17 MS. O'DELL:</p> <p>18 Q As a part of -- of -- of -- of your</p> <p>19 methodology outside litigation, would you</p> <p>20 routinely rely on testing data as a part of that</p> <p>21 process?</p> <p>22 A Would I -- would I be doing the</p> <p>23 testing? Sometimes.</p> <p>24 Q No, sir. Just -- but rely on data,</p>	<p style="text-align: right;">Page 464</p> <p>1 questions on a couple of different topics.</p> <p>2 First, let me show you or direct your attention</p> <p>3 back to the deposition of Patrick Downey.</p> <p>4 A Sure.</p> <p>5 Q You were asked some questions by</p> <p>6 Mr. Ferguson about the Downey deposition. And,</p> <p>7 if I recall correctly, the suggestion was made</p> <p>8 that Mr. Downey did not testify that Imerys</p> <p>9 certified that the talc powder sold to</p> <p>10 Johnson & Johnson was asbestos-free. Do you</p> <p>11 remember those questions?</p> <p>12 A Yes.</p> <p>13 MR. FERGUSON:</p> <p>14 Object to the form.</p> <p>15 A I remember the questions.</p> <p>16 MS. O'DELL:</p> <p>17 Q In -- you know, direct your attention</p> <p>18 to page 508 of the transcript and to line number</p> <p>19 15.</p> <p>20 A 508?</p> <p>21 Q 506. Excuse me. I'm sorry. 506, line</p> <p>22 15.</p> <p>23 A Okay.</p> <p>24 Q And the question was asked to</p>
<p style="text-align: right;">Page 463</p> <p>1 testing data, in regard to your process of --</p> <p>2 A Sure.</p> <p>3 Q -- of evaluating.</p> <p>4 A Of course. In fact, that's one of --</p> <p>5 one of the problems is waiting for data to come</p> <p>6 in from the lab.</p> <p>7 Q That's right.</p> <p>8 You mentioned earlier today that you</p> <p>9 referenced the report of -- reports of Dr. --</p> <p>10 Dr. Longo --</p> <p>11 A Right.</p> <p>12 Q -- and Rigler.</p> <p>13 Did you rely on the data reported in</p> <p>14 Dr. Longo's reports in reaching your opinions?</p> <p>15 A Yes.</p> <p>16 Q And would, as I've mentioned,</p> <p>17 testing --</p> <p>18 Or let me just ask you in a non-leading</p> <p>19 way.</p> <p>20 As a professional geologist, would you</p> <p>21 routinely rely on testing data as a part of</p> <p>22 your -- your responsibility?</p> <p>23 A Yes.</p> <p>24 Q Let me ask you a couple of different --</p>	<p style="text-align: right;">Page 465</p> <p>1 Mr. Downey: "Why were you not able to give a</p> <p>2 true -- a simple true-or-false answer to the</p> <p>3 question of asbestos-free?"</p> <p>4 Answer: "Well, I was trying to be</p> <p>5 scientifically accurate, perhaps hypertechnical,</p> <p>6 but it was the conjunction of the terms</p> <p>7 'certified' and 'asbestos-free.' That's not the</p> <p>8 language that we use in certifications. But if</p> <p>9 you're asking me if our product contains</p> <p>10 asbestos, no, it does not."</p> <p>11 And, in fact, did Mr. Downey testify</p> <p>12 that the product provided to Johnson & Johnson</p> <p>13 for its talcum powder products were free of</p> <p>14 asbestos?</p> <p>15 MR. FERGUSON:</p> <p>16 Objection to form.</p> <p>17 MR. FROST:</p> <p>18 Objection to form.</p> <p>19 A It certainly sounds that way in -- in</p> <p>20 the deposition.</p> <p>21 MS. O'DELL:</p> <p>22 Q Is that what you were referring to?</p> <p>23 A Yes, that is what I was referring to.</p> <p>24 Q Thanks, Doctor. You can put that to</p>

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<p>1 the -- to the side.</p> <p>2 A Do you want it or not?</p> <p>3 Q Just put it there. Thanks so much.</p> <p>4 If you will now turn to page 5 of your</p> <p>5 report.</p> <p>6 A Okay.</p> <p>7 Q And, at the bottom of the page, in the</p> <p>8 last paragraph on page 5, it's paragraph</p> <p>9 beginning "in 2003." And on the second sentence</p> <p>10 of that paragraph, it says, "Chinese talc</p> <p>11 occurrences included in those" -- excuse me --</p> <p>12 "including those in the Guangxi province have</p> <p>13 been described in certain Imerys documents."</p> <p>14 And then several are listed there.</p> <p>15 A Right.</p> <p>16 MR. FROST:</p> <p>17 Objection to form.</p> <p>18 MS. O'DELL:</p> <p>19 Q And I think Johnson & Johnson counsel</p> <p>20 showed you several documents, and I think you</p> <p>21 indicated that there was an error in the Bates</p> <p>22 reference.</p> <p>23 A Right. There is.</p> <p>24 Q Let me show you what I'm marking as</p>	<p>1 documents that you intended to refer to?</p> <p>2 A Yes. I almost think I had this</p> <p>3 document that has a different Bates number on it.</p> <p>4 But, yeah, this -- this is -- that's it.</p> <p>5 Q Okay. Thank you.</p> <p>6 MR. FROST:</p> <p>7 Can I see the document?</p> <p>8 MS. O'DELL:</p> <p>9 Q All right. In --</p> <p>10 Now, I ask -- if I could ask you,</p> <p>11 Doctor, to pull out of your -- the stack over</p> <p>12 there -- and maybe Lois will help us -- Exhibit</p> <p>13 14.</p> <p>14 A Okay. Getting close.</p> <p>15 Q Okay.</p> <p>16 A Okay. Got it.</p> <p>17 Q And Exhibit 14 refers to -- the subject</p> <p>18 is characterization of Guan- -- of the Guangxi 1</p> <p>19 crude and Cimpact 710 product.</p> <p>20 A Right.</p> <p>21 Q Do you remember the discussion with</p> <p>22 Johnson & Johnson counsel on that document?</p> <p>23 A Sure.</p> <p>24 Q Let me ask you to turn to, while you're</p>
Page 467	Page 469
<p>1 Exhibit 32 to your deposition.</p> <p>2 (DEPOSITION EXHIBIT NUMBER 32</p> <p>3 WAS MARKED FOR IDENTIFICATION.)</p> <p>4 MS. O'DELL:</p> <p>5 Q Is Exhibit 32 one of the documents that</p> <p>6 you intended to reference at that portion of your</p> <p>7 report?</p> <p>8 I'm sorry. Doctor, can I take that</p> <p>9 back just for a second?</p> <p>10 A Sure.</p> <p>11 Q I've added another document to it. I</p> <p>12 didn't intend to do that. It just was in my</p> <p>13 stack.</p> <p>14 MR. FROST:</p> <p>15 Leigh, can you identify what document</p> <p>16 this is?</p> <p>17 MS. O'DELL:</p> <p>18 Sure. It is JNJ00059273.</p> <p>19 A Yeah.</p> <p>20 MR. BILLINGS-KANG:</p> <p>21 Is that JNJ or J&J?</p> <p>22 MS. O'DELL:</p> <p>23 N.</p> <p>24 Q Is that the document, one of the</p>	<p>1 holding the document, Doctor -- maybe not put it</p> <p>2 too far away from you -- to page 8 of -- of your</p> <p>3 report. And, at the bottom of page 8 of your</p> <p>4 report, you include a sentence, "It is known that</p> <p>5 Rio Tinto identified problems with Guangxi talc</p> <p>6 ores in 1997 which resulted in the recommendation</p> <p>7 that a Luzenac representative be present at the</p> <p>8 mine during the mining and sorting process."</p> <p>9 A Right.</p> <p>10 Q Do you recall writing that?</p> <p>11 A Right. Yes.</p> <p>12 Q Turn to the last page of Exhibit 14 in</p> <p>13 the Recommendations section. Is the</p> <p>14 recommendation that you included in your report</p> <p>15 contained in the paragraph on page 4 of this</p> <p>16 document?</p> <p>17 A It is.</p> <p>18 Q And there's a sentence -- two sentences</p> <p>19 at the bottom. It says, "A Luzenac</p> <p>20 representative" --</p> <p>21 I'm reading from page 4 of Exhibit 14.</p> <p>22 "A Luzenac representative should be</p> <p>23 available at the mine during the mining and</p> <p>24 sorting process in order to confirm that the</p>

<p style="text-align: right;">Page 470</p> <p>1 ore -- order is being handled per the negotiated 2 contract parameters. Meeting the ore at the port 3 will never allow us to control the quality and 4 chemistry of the crude we are ordering." 5 Is that -- did I read that correctly? 6 A Right. You did. 7 Q Is that what you were referring to in 8 your report? 9 A Uh-huh. It is. 10 Q Thank you, Doctor. Yeah. 11 You also, still speaking of China, were 12 asked about the sampling method that was used in 13 relation to Chinese ore once it reached -- 14 reached the port in Houston. 15 A Correct. 16 MR. FROST: 17 Objection to form. 18 MS. O'DELL: 19 Q Let me ask you to look at what I'm 20 marking as Exhibit 33. 21 (DEPOSITION EXHIBIT NUMBER 33 22 WAS MARKED FOR IDENTIFICATION.) 23 MS. O'DELL: 24 Q And it's Imerys 036949.</p>	<p style="text-align: right;">Page 472</p> <p>1 A I think it does. 2 Q And is -- is that at least one of the 3 reasons that you referenced that publication in 4 your report? 5 A It is. 6 Q Let me ask you, Doctor, to put that 7 aside for a moment. 8 You were asked a series of questions 9 regarding whether you would publish your expert 10 report in the peer-reviewed literature. I think 11 your response was no. Why did you respond to 12 that question in the negative? 13 MR. FROST: 14 Objection to form. 15 A The -- to start with, as with any work 16 like this, there is a confidentiality agreement 17 that comes in very quickly. And publishing any 18 part of this would -- would violate the agreement 19 that -- that I signed. 20 The -- part of the problem with this is 21 that if you -- if you try to publish something in 22 a peer-reviewed journal, how is a peer-reviewer 23 ever gonna be able to -- to -- to evaluate a 24 report like this? He's not gonna have access to</p>
<p style="text-align: right;">Page 471</p> <p>1 Is Exhibit 33 the sampling protocol 2 regarding Chinese ore that you were referring to? 3 A Yes. 4 Q Let me ask you, Dr. Cook -- 5 I'm gonna put that right here for the 6 moment. And on an exhibit marked -- I think it 7 was exhibit -- yes -- 21. Let me hand it to you. 8 It's a paper by Marconi and Verdel? 9 A Right. 10 Q And if you'll turn to page -- 11 On the -- on the document itself, the 12 page numbers, it's -- it's page 112. 13 A Okay. 14 Q Does Table 3 that appears on page 112 15 of this article show test results regarding 16 cosmetic talc? 17 MR. FROST: 18 Objection to the form. 19 A I think it does. 20 MS. O'DELL: 21 Q Uh-huh. And if you'll look at the 22 lower third of the table, does it -- the chart 23 indicate that there were asbestos fibers found in 24 cosmetic talc samples?</p>	<p style="text-align: right;">Page 473</p> <p>1 any -- any of the materials. So it wouldn't make 2 sense. It would be off limits. 3 MS. O'DELL: 4 Q Is that because many of the materials, 5 documents that you've cited in your report, those 6 would be subject to a confidentiality order and 7 it would be a violation of that order? 8 A That's -- that's what I mean. I mean, 9 I sign a confidentiality agreement not to divulge 10 any of this. So -- 11 Q Okay. Let me ask you to turn in your 12 report, Dr. Cook, to page 31. 13 A Okay. 14 Q And, specifically, I would direct your 15 attention to the table that reports some of the 16 nickel analyses that are -- that are contained in 17 your report. 18 A Okay. 19 Q And -- and you were asked questions 20 regarding whether this -- the samples that were 21 tested were finished product. And let me just 22 back up and ask. Were the samples, many of which 23 that you report in this chart, were they finished 24 talc product?</p>

<p style="text-align: right;">Page 474</p> <p>1 MR. FROST: 2 Objection to form. 3 A That is my understanding, based on the 4 description of the samples in the cited 5 references. 6 MS. O'DELL: 7 Q All right. And, in fact, number 3 in 8 the chart, the description is baby powder. 9 Correct? 10 A Correct. 11 Q And in that -- that has, I think, three 12 samples that were tested. And were the findings 13 1500 parts per million, 1480 parts per million, 14 and 1500 parts per million, respectively? 15 MR. FROST: 16 Objection to form. 17 A That's correct. 18 MS. O'DELL: 19 Q And would it be fair to say that a 20 finding of greater than, you know, 1400 or 1500 21 parts per million, would it be fair to say that 22 that is an extremely high level of -- of nickel? 23 MR. FERGUSON: 24 Objection for form.</p>	<p style="text-align: right;">Page 476</p> <p>1 Objection. Move to strike answer as 2 nonresponsive and speculative. 3 MS. O'DELL: 4 Oppose the motion. 5 Q The -- the -- and, in this table for 6 nickel as well as the table that is compiled for 7 chromium and cobalt, does that include values or 8 data from annual samples that were provided to 9 Johnson & Johnson? 10 A Yes. 11 MR. FROST: 12 Objection. 13 MS. O'DELL: 14 Q And is it your understanding, based on 15 your review of the data, that that would be 16 finished product? 17 A Yes. Finished in the sense that it's 18 gonna go toward packaging now when they're done 19 with the processing. 20 Q Okay. Let me ask you to turn to page 21 32 of your report that relates to your discussion 22 of -- of chromium. And, Dr. Cook, let me ask you 23 a general question about the test data that's 24 reported in this chart.</p>
<p style="text-align: right;">Page 475</p> <p>1 MR. FROST: 2 Objection to form. Also, object to the 3 question since he's already admitted he's not 4 qualified to answer that. 5 THE WITNESS: 6 No, I am. The way she asked the 7 question, I am. I've dealt with geochemical 8 nickel for -- almost for the entire time I was at 9 Auburn. 10 And anything over a hundred parts per 11 million, when we're doing our field work, that is 12 an indication that we've got an unusual rock type 13 that we're looking at. 14 And, in fact, the -- the platinum and 15 nickel exploration that I'm doing right now, if 16 we could find numbers this high, we'd be 17 thrilled, because a value of 1500 parts per 18 million nickel is almost ore grade for an 19 open-pit operation, and it -- it indicates that 20 we're looking at a serpentinitized ultramafic rock 21 that may have economic nickel or PGMs. 22 MS. O'DELL: 23 Q Okay. And do the -- 24 MR. FROST:</p>	<p style="text-align: right;">Page 477</p> <p>1 In each instance, do the chromium 2 numbers that were seen in these test results 3 exceed the Johnson & Johnson specification upper 4 limit of normal for chromium by, you know, orders 5 of magnitude? 6 MR. FROST: 7 Objection to form. 8 MR. BILLINGS-KANG: 9 Objection to form. 10 A They are far higher than the 10 ppm. 11 MS. O'DELL: 12 Q Would that also be true regarding the 13 test results that are reported in relation to 14 cobalt in -- 15 A Yes. 16 Q You were asked a number of questions 17 regarding beneficiation and the process that was 18 undertaken to process talc ore. Let me ask you 19 specific questions about Vermont. 20 Having reviewed the descriptions of the 21 beneficiation process at West Windsor, was there 22 anything in that beneficiation process that would 23 have removed high levels of nickel found in talc 24 ore?</p>

<p style="text-align: right;">Page 478</p> <p>1 MR. FROST:</p> <p>2 Objection to form.</p> <p>3 A No. I don't think it was -- would be</p> <p>4 possible.</p> <p>5 MS. O'DELL:</p> <p>6 Q Similarly, in relation to cobalt, was</p> <p>7 there any part of the beneficiation process at</p> <p>8 the West Windsor mill in Vermont that would have</p> <p>9 addressed high levels of cobalt?</p> <p>10 MR. FROST:</p> <p>11 Objection.</p> <p>12 A There's a possibility that if all of</p> <p>13 the cobalt was contained in cobaltite, which is a</p> <p>14 cobalt arsenic -- that's a dense mineral -- it</p> <p>15 might sink in a flotation cell and be removed</p> <p>16 that way. But the numbers that I've got are on</p> <p>17 the finished product, not on the -- not on ore</p> <p>18 going in.</p> <p>19 MS. O'DELL:</p> <p>20 Q And that would suggest that, in fact,</p> <p>21 the beneficiation process did not affect it?</p> <p>22 A It's probably --</p> <p>23 MR. FROST:</p> <p>24 Objection to the form.</p>	<p style="text-align: right;">Page 480</p> <p>1 fibrous talc.</p> <p>2 Q And, therefore, to the degree that</p> <p>3 fibrous talc was mined from the ore body and --</p> <p>4 and made a part of the ore, then is it your</p> <p>5 opinion that the beneficiation process would not</p> <p>6 remove the fibrous talc, you know, from the</p> <p>7 product?</p> <p>8 A I don't -- I don't see how it could.</p> <p>9 You're referring to West Windsor;</p> <p>10 right?</p> <p>11 Q Yes.</p> <p>12 A I don't see how it could.</p> <p>13 Q Would the beneficiation process at</p> <p>14 West Windsor have been effective for purposes of</p> <p>15 removing high levels of arsenic?</p> <p>16 MR. FROST:</p> <p>17 Objection to form.</p> <p>18 A I think it's possible that some arsenic</p> <p>19 could have come out in the sink fraction of the</p> <p>20 flotation cells.</p> <p>21 MS. O'DELL:</p> <p>22 Q If asbestos was mined and removed</p> <p>23 during the mining process, is there anything in</p> <p>24 the beneficiation process at West Windsor that</p>
<p style="text-align: right;">Page 479</p> <p>1 MR. FERGUSON:</p> <p>2 Objection to the form.</p> <p>3 A That's correct.</p> <p>4 MS. O'DELL:</p> <p>5 Q Let me ask it a different way to</p> <p>6 address these.</p> <p>7 Based on the numbers, the test data</p> <p>8 that you reviewed regarding finished talc powder,</p> <p>9 is it your opinion that the beneficiation process</p> <p>10 at West Windsor was not affected to remove high</p> <p>11 levels of cobalt?</p> <p>12 MR. FROST:</p> <p>13 Objection.</p> <p>14 A I don't think it could.</p> <p>15 MS. O'DELL:</p> <p>16 Q Okay. Let me ask you about fibrous</p> <p>17 talc in regard to the beneficiation process. Is</p> <p>18 it -- do you have an opinion as to whether the</p> <p>19 beneficiation process at West Windsor would</p> <p>20 remove fibrous talc?</p> <p>21 A I don't see how it's possible,</p> <p>22 particularly in the flotation circuit. I think</p> <p>23 that the flotation process is not gonna be able</p> <p>24 to distinguish platy non-fibrous talc from</p>	<p style="text-align: right;">Page 481</p> <p>1 would have removed asbestos as part of the</p> <p>2 processing?</p> <p>3 A Well, there -- there are reagents that</p> <p>4 could suppress chrysotile. I don't know of any</p> <p>5 that would suppress amphibole asbestos. But I</p> <p>6 didn't see anything in the documents I was</p> <p>7 supplied that would indicate that there was an</p> <p>8 attempt made or that there was any kind of design</p> <p>9 that was -- was pointed toward removal of -- of</p> <p>10 asbestos.</p> <p>11 Q You were asked a number of questions</p> <p>12 about the chart in your report addressing</p> <p>13 positive test results for asbestos. Do you</p> <p>14 recall those questions?</p> <p>15 A Yes.</p> <p>16 Q And I think that counsel for Johnson &</p> <p>17 Johnson addressed five test results, calling them</p> <p>18 into question as industrial talc.</p> <p>19 A Correct.</p> <p>20 Q And in -- in those instances --</p> <p>21 Strike that.</p> <p>22 Is there anything that -- that counsel</p> <p>23 presented to you today that would undermine your</p> <p>24 opinions regarding the other test results</p>

<p style="text-align: right;">Page 482</p> <p>1 contained in the chart?</p> <p>2 A No.</p> <p>3 Q And, generally speaking, if you know,</p> <p>4 how many other positive test results for asbestos</p> <p>5 are contained in a chart besides the five that he</p> <p>6 pointed out?</p> <p>7 A Oh, there's over a hundred.</p> <p>8 Q And are those test results supportive</p> <p>9 of your opinion that the talc deposits in Italy</p> <p>10 and Vermont contained fibrous asbestos --</p> <p>11 asbestos mills?</p> <p>12 MR. FROST:</p> <p>13 Objection to form.</p> <p>14 A The published information and some of</p> <p>15 the unpublished reports on Italy suggested there</p> <p>16 could be some in that talc. And, of course, I've</p> <p>17 got lots of data on Vermont that would suggest</p> <p>18 that.</p> <p>19 MS. O'DELL:</p> <p>20 Q You were asked questions about</p> <p>21 selective mining today, and --</p> <p>22 Before I do that --</p> <p>23 Excuse me. Also in regard to the</p> <p>24 fibrous talc chart, I think the counsel called</p>	<p style="text-align: right;">Page 484</p> <p>1 Q Earlier today you were asked a lot of</p> <p>2 questions by counsel, and a lot of suggestions</p> <p>3 were made that somehow documents, you know, were</p> <p>4 withheld by plaintiffs' counsel. Do you recall</p> <p>5 that?</p> <p>6 A Yes.</p> <p>7 MR. FROST:</p> <p>8 Objection to form.</p> <p>9 MS. O'DELL:</p> <p>10 Q At the beginning of your engagement in</p> <p>11 this case, did you provide a list of -- of</p> <p>12 documents, really document requests, that you</p> <p>13 asked that those documents be searched for and,</p> <p>14 to the degree made available by defendants,</p> <p>15 provided to you?</p> <p>16 A Yes.</p> <p>17 Q Do you have any reason to believe</p> <p>18 that -- that documents were withheld from you</p> <p>19 in -- in rendering your opinions?</p> <p>20 MR. FROST:</p> <p>21 Objection to form. Misstates</p> <p>22 questioning and testimony.</p> <p>23 A I have no reason to believe that --</p> <p>24 that anybody has withheld anything. You know,</p>
<p style="text-align: right;">Page 483</p> <p>1 into question maybe one of the line items or the</p> <p>2 entries --</p> <p>3 Two. Excuse me.</p> <p>4 -- two of the entries in the fibrous</p> <p>5 talc chart that you have in your report.</p> <p>6 A Right.</p> <p>7 Q Is there any data that you've been</p> <p>8 presented today or question that would -- data or</p> <p>9 information you've been presented today that</p> <p>10 would call into question in your mind any of the</p> <p>11 other positive test result -- results for fibrous</p> <p>12 talc?</p> <p>13 A No.</p> <p>14 MR. FROST:</p> <p>15 Objection.</p> <p>16 MS. O'DELL:</p> <p>17 Q Are -- are you relying on the data</p> <p>18 contained in the asbestos chart to support your</p> <p>19 opinions in this case?</p> <p>20 A Yes.</p> <p>21 Q Are you relying on the data contained</p> <p>22 in the fibrous talc chart to support your</p> <p>23 opinions?</p> <p>24 A Yes.</p>	<p style="text-align: right;">Page 485</p> <p>1 my -- my approach is everybody's on the up and</p> <p>2 up.</p> <p>3 MS. O'DELL:</p> <p>4 Q Do you -- did you see, in reaching your</p> <p>5 opinions in regard to asbestos, did you see not</p> <p>6 only positive test results but did you also look</p> <p>7 at negative test results?</p> <p>8 A Yes, plenty.</p> <p>9 Q And did you consider those results also</p> <p>10 in --</p> <p>11 A Yes.</p> <p>12 Q Excuse me. Let me finish. Excuse me.</p> <p>13 -- in reaching your opinions in this</p> <p>14 case?</p> <p>15 A Yes, of course.</p> <p>16 Q You were asked some questions about</p> <p>17 selective mining, and -- and you -- you made a</p> <p>18 statement that you -- it was your opinion that</p> <p>19 selective mining practices had not been used</p> <p>20 in -- in mining talc --</p> <p>21 MR. FROST:</p> <p>22 Objection.</p> <p>23 MS. O'DELL:</p> <p>24 Q -- for purposes of sourcing talcum</p>

<p style="text-align: right;">Page 486</p> <p>1 powder products.</p> <p>2 MR. FROST:</p> <p>3 Objection to form.</p> <p>4 MS. O'DELL:</p> <p>5 Q Do you recall that --</p> <p>6 A Yes.</p> <p>7 Q -- testimony?</p> <p>8 What's the basis for your opinion that</p> <p>9 appropriate selective mining practices were not</p> <p>10 used?</p> <p>11 A Well, to start with, they're not</p> <p>12 described in any of the documents. And -- and</p> <p>13 the -- the few photographs that we've got of the</p> <p>14 mines don't suggest selective mining. It -- it</p> <p>15 just isn't there.</p> <p>16 Q And if you'll look on page 8, is --</p> <p>17 does -- is the photograph on page 8 one of the --</p> <p>18 the photographs that you considered in reaching</p> <p>19 your opinion regarding selective mining?</p> <p>20 A Yes.</p> <p>21 Q And -- and describe for us, Dr. Cook,</p> <p>22 why that photograph does not depict appropriate</p> <p>23 selective mining techniques.</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 488</p> <p>1 Objection to form.</p> <p>2 MR. FERGUSON:</p> <p>3 Objection.</p> <p>4 A I wouldn't. I don't see anything in</p> <p>5 this photograph that would suggest that there was</p> <p>6 a selection of higher grade material versus lower</p> <p>7 grade.</p> <p>8 MR. FROST:</p> <p>9 Move to strike answer as speculative.</p> <p>10 MS. O'DELL:</p> <p>11 Q Is your answer speculative?</p> <p>12 MR. FROST:</p> <p>13 Objection to form.</p> <p>14 A It's based on my observation of the</p> <p>15 photograph. It's conclusion.</p> <p>16 MS. O'DELL:</p> <p>17 Q And, in reaching that conclusion, have</p> <p>18 you used your, you know, your special expertise</p> <p>19 as a mining engineer and, you know, professor of</p> <p>20 geology that teaches mining practices?</p> <p>21 MR. FROST:</p> <p>22 Objection to form.</p> <p>23 A Yes.</p> <p>24 MS. O'DELL:</p>
<p style="text-align: right;">Page 487</p> <p>1 Objection to form.</p> <p>2 A Okay. This one is fairly simple.</p> <p>3 You've got a single loader, but you've got three</p> <p>4 piles of broken rock that would suggest that he's</p> <p>5 gonna be loading ore from material derived from</p> <p>6 three separate shots, and these -- these shot</p> <p>7 piles are very close to each other. And there's</p> <p>8 no indication here at all that this has anything</p> <p>9 to do with selective mining. I mean, the only --</p> <p>10 the only way this is selective mining is if</p> <p>11 everything we see in the photograph that's broken</p> <p>12 ore is good ore. We're gonna mine all of it.</p> <p>13 But -- but this is not what I would expect to</p> <p>14 see.</p> <p>15 MS. O'DELL:</p> <p>16 Q Is -- is -- based on your knowledge of</p> <p>17 the geology that --</p> <p>18 Let me strike that.</p> <p>19 Based on your review of the core logs</p> <p>20 in -- that have been produced in this case</p> <p>21 regarding the Vermont mines, would you expect in</p> <p>22 a picture like this that all the -- the rocks</p> <p>23 would be, you know, pure talc?</p> <p>24 MR. FROST:</p>	<p style="text-align: right;">Page 489</p> <p>1 Q You were asked a number of questions</p> <p>2 regarding samples in the sampling process that</p> <p>3 was utilized over the course of -- of the -- I</p> <p>4 guess more than 50 years --</p> <p>5 A Right.</p> <p>6 Q -- that we've discussed today.</p> <p>7 Quickly, Doctor, just in a setting like the ones</p> <p>8 described, particularly in Vermont, is a monthly</p> <p>9 composite sample representative?</p> <p>10 MR. FROST:</p> <p>11 Objection to form.</p> <p>12 A It wouldn't be to me.</p> <p>13 MS. O'DELL:</p> <p>14 Q Why?</p> <p>15 A Because --</p> <p>16 And -- and we can use arsenic as an</p> <p>17 example. We know that there were -- there were</p> <p>18 some high arsenic ores that went to the West</p> <p>19 Windsor mill.</p> <p>20 Suppose you had one day's run at</p> <p>21 Windsor mill that had an arsenic value of 10</p> <p>22 parts per million. That exceeds the acceptable</p> <p>23 limit. How would you know that that ever went</p> <p>24 through the mill? It's gonna go through the mill</p>

<p style="text-align: right;">Page 490</p> <p>1 and then go into a silo, and, in that silo, 2 there's gonna be a layer that is represented by 3 that product. 4 Let's say the next day you've got 5 perfect talc, hundred percent talc, no arsenic at 6 all. Okay. That's gonna go in and it's gonna 7 sit on top of the layer of out-of-spec talc. 8 Well, if all you have is a daily 9 sample, then if you've got one that's 10 parts 10 per million arsenic, had you analyzed it that 11 day, and the -- the other 29 or 30 samples are 12 one part per million arsenic, then your composite 13 at the end of the month is gonna be in spec, but 14 you're gonna have some talc in that silo that 15 isn't. 16 And that's my objection to the way 17 compositing is done. I think it's definitely 18 something that can be done in some situations, 19 but I think here it's -- it's not a good idea. 20 MR. FROST: 21 Move to strike answer as speculative. 22 MS. O'DELL: 23 Q Is that -- is that based on -- 24 A That is not a speculation. That is a</p>	<p style="text-align: right;">Page 492</p> <p>1 your review of the core logs that have been 2 produced in litigation, was there evidence in 3 those core logs of the presence of fibrous talc? 4 A Fibrous talc, yes, is -- was mentioned 5 in some of the core logs. 6 Q And was there also references to the 7 presence of amphiboles? 8 A Of amphiboles? 9 Q Yes. 10 A Oh, yeah, sure. 11 Q And -- and, in some of those cases, 12 were -- were the presence of fibrous amphiboles 13 noted? 14 A Yes. 15 Q Let me ask you, in regard to asbestos 16 testing, I think it was -- you referenced a 17 document in your report regarding a testing 18 procedure where samples were tested every six 19 months for asbestos in -- in Vermont. Do you 20 recall that? 21 A Yes. 22 Q And would sampling and testing -- would 23 a six-month sample for talc -- 24 Strike that.</p>
<p style="text-align: right;">Page 491</p> <p>1 statement of fact. 2 MR. FROST: 3 Move to strike nonresponsive answer. 4 MS. O'DELL: 5 Q Is that based on your evaluation of the 6 variability of the geology of the deposits in 7 Vermont? 8 MR. FROST: 9 Objection to form. 10 A Yes. And we already know there's 11 variation, and I just used arsenic as a good 12 example. Because if you look at the Hamm mine, 13 that's the one mine that we have some good 14 drilling numbers throughout the pit. Clearly 15 shows that there are areas of the mine that are 16 high arsenic, way out of spec -- 17 No. I'm sorry. It was the Rainbow 18 mine. 19 And then there are areas in the mine 20 that are great. 21 MS. O'DELL: 22 Q Uh-huh. And in your -- in your 23 review -- 24 You just mentioned the core logs. In</p>	<p style="text-align: right;">Page 493</p> <p>1 Let me ask you, is that a 2 representative way to test talc powder for 3 asbestos? 4 MR. FROST: 5 Objection to form. 6 A A six-month composite? 7 MS. O'DELL: 8 Q Yes. 9 A Well, I wouldn't be happy with it. 10 Q Why? 11 A Because the sample that's actually run 12 weighs less than a gram, and you're -- you're 13 trying to come up with a way to validate the fact 14 that that less than a gram of material is -- is 15 gonna be representative of perhaps a thousand 16 tons of ore, 2,000 tons. It's -- it's very hard 17 to imagine that you can show that it would be. 18 Q Under any mathematical model, would 19 that small of a sample that's tested be 20 representative of tens of thousands of tons of 21 ore? 22 MR. FROST: 23 Objection to form. 24 A I think it would be probably</p>

<p style="text-align: right;">Page 494</p> <p>1 impossible. There's some things that you could</p> <p>2 do to move it along toward the</p> <p>3 representativeness, but I don't think they were</p> <p>4 done.</p> <p>5 MS. O'DELL:</p> <p>6 Q Are you -- are your opinions in this</p> <p>7 case contained in your report that's dated</p> <p>8 January 22nd, 2019, as well as your deposition</p> <p>9 that you've given here today?</p> <p>10 A Are they --</p> <p>11 Q As well as the deposition?</p> <p>12 A No. What was the first part of the</p> <p>13 question?</p> <p>14 Q Are your opinions in this case</p> <p>15 contained in your --</p> <p>16 A Oh, are they contained? Sure. Of</p> <p>17 course.</p> <p>18 Q Let me finish.</p> <p>19 -- amended report that's dated January</p> <p>20 22nd, 2019, as well as your deposition that</p> <p>21 you've given here today?</p> <p>22 A Yes.</p> <p>23 Q All right. I have nothing further.</p> <p>24 Thank you, Doctor.</p>	<p style="text-align: right;">Page 496</p> <p>1 I want to talk about that. Okay?</p> <p>2 A Sure.</p> <p>3 Q And remind me, which mine was that at?</p> <p>4 A Okay. That one was Argonaut, that</p> <p>5 photograph was. But we've got some in the back</p> <p>6 that are -- I think there's a Hamm mine picture</p> <p>7 possibly in there.</p> <p>8 Q All right. So with regard to the</p> <p>9 Argonaut mine and your conclusion that -- that</p> <p>10 appropriate selective mining procedures were not</p> <p>11 being carried out, how many photographs did you</p> <p>12 look at?</p> <p>13 A I looked at everything we were given.</p> <p>14 And it's -- it's only a handful, not --</p> <p>15 Q Well, and does a handful mean five or</p> <p>16 less?</p> <p>17 A It's probably more than five but less</p> <p>18 than ten.</p> <p>19 Q Okay. So -- so somewhere between five</p> <p>20 and ten photographs you looked at. Correct?</p> <p>21 A Well, I also looked at Google Earth,</p> <p>22 which, you know, has its own, you know, set of</p> <p>23 photographs that you can look at.</p> <p>24 Q All right. And how many Google Earth</p>
<p style="text-align: right;">Page 495</p> <p>1 MR. FROST:</p> <p>2 I'd just like two minutes. Actually,</p> <p>3 no. You guys, why don't you guys stay here? I</p> <p>4 think we'll be quick. I'll take Mr. Ferguson</p> <p>5 outside.</p> <p>6 VIDEOGRAPHER:</p> <p>7 Going off the record.</p> <p>8 (OFF THE RECORD.)</p> <p>9 VIDEOGRAPHER:</p> <p>10 We're back on the record. The time is</p> <p>11 7:10 p.m.</p> <p>12 MR. FERGUSON:</p> <p>13 I don't think Mr. --</p> <p>14 Oh, I'm sorry.</p> <p>15 I don't think Mr. Frost has any</p> <p>16 questions. Right, Jack?</p> <p>17 MR. FROST:</p> <p>18 That's correct.</p> <p>19 EXAMINATION</p> <p>20 BY MR. FERGUSON:</p> <p>21 Q Okay. Just very briefly, Dr. Cook.</p> <p>22 So, with regarding to the -- the photographs that</p> <p>23 you observed that had to do with the selective</p> <p>24 mining issue you just discussed with Miss O'Dell,</p>	<p style="text-align: right;">Page 497</p> <p>1 photographs did you look at?</p> <p>2 A Well, it depends. You know, they have</p> <p>3 a historical, you know, button you can push. And</p> <p>4 I don't remember how many different dates there</p> <p>5 were of the Ludlow area. But there were -- there</p> <p>6 were four or five.</p> <p>7 Q Okay. So do you have copies of the --</p> <p>8 A No. I didn't print them.</p> <p>9 Q -- photographs?</p> <p>10 A I didn't save them. But, I mean,</p> <p>11 they're easy to go back to and get.</p> <p>12 Q Okay.</p> <p>13 A And I'd -- you know, I'd be more than</p> <p>14 happy to tell you why I made the comment about</p> <p>15 couldn't see the evidence of the selective</p> <p>16 mining.</p> <p>17 If you look at the photographs that</p> <p>18 I --</p> <p>19 Q I don't think -- I -- I don't have a</p> <p>20 question on the table, but --</p> <p>21 A Oh. I thought you did, but --</p> <p>22 Q I didn't.</p> <p>23 A Okay.</p> <p>24 Q So I'm trying to get the number of</p>

<p style="text-align: right;">Page 498</p> <p>1 photographs.</p> <p>2 A Oh, okay.</p> <p>3 Q So between five and ten photographs</p> <p>4 that you were provided that you looked at.</p> <p>5 A Correct.</p> <p>6 Q Correct?</p> <p>7 A Yes.</p> <p>8 Q And then some Google Earth</p> <p>9 photographs --</p> <p>10 A Google Earth.</p> <p>11 Q -- that you -- you haven't shared with</p> <p>12 us. Correct?</p> <p>13 A Correct.</p> <p>14 MS. O'DELL:</p> <p>15 Object to the form.</p> <p>16 MR. FERGUSON:</p> <p>17 Q And when were the Google Earth</p> <p>18 photographs taken? I mean, when --</p> <p>19 A They go back -- I think the most recent</p> <p>20 one was a two -- I think there might have been a</p> <p>21 2018 photograph. And then they go back. It's an</p> <p>22 irregular number of years that they -- that they</p> <p>23 present you with. But I think that maybe --</p> <p>24 They had some that were so far back</p>	<p style="text-align: right;">Page 500</p> <p>1 It's mined out.</p> <p>2 MS. O'DELL:</p> <p>3 Objection to form.</p> <p>4 MR. FERGUSON:</p> <p>5 Q Excuse me?</p> <p>6 A It's mined out.</p> <p>7 Q Okay.</p> <p>8 A And if you're looking at a 2018</p> <p>9 photograph, the material that was being mined in,</p> <p>10 say, 1995, I mean, you're looking at a part of a</p> <p>11 hole in the ground.</p> <p>12 Q Well, let's focus on the five to ten</p> <p>13 photographs. Okay?</p> <p>14 A Okay.</p> <p>15 Q Okay? Right? The five to ten</p> <p>16 photographs you were provided of the Argonaut</p> <p>17 mine --</p> <p>18 A Okay.</p> <p>19 Q -- from which you concluded that</p> <p>20 selective mining procedures were not being</p> <p>21 applied properly.</p> <p>22 A Correct.</p> <p>23 Q Okay?</p> <p>24 MS. O'DELL:</p>
<p style="text-align: right;">Page 499</p> <p>1 that they were useless. The quality of the</p> <p>2 photograph was no good. And, so, with that</p> <p>3 thought in mind, I'm gonna say there were</p> <p>4 probably three or four of Ludlow area that were</p> <p>5 useful.</p> <p>6 And I can't tell you what the oldest</p> <p>7 one was, but it would -- it would be, say, 2003,</p> <p>8 maybe. Maybe -- maybe one that was pre-2000.</p> <p>9 Q But with regard to the photographs that</p> <p>10 you looked at that were 2003 or post-2003, those</p> <p>11 were when that mine was no longer being used to</p> <p>12 source cosmetic talc; correct?</p> <p>13 MS. O'DELL:</p> <p>14 Object to the form.</p> <p>15 A Yeah, that's right. And that's why I</p> <p>16 said I'd be glad to, you know, discuss the ones</p> <p>17 in here, because they're pre-2003.</p> <p>18 MR. FERGUSON:</p> <p>19 Q So -- so, essentially, the Google Earth</p> <p>20 photographs, which are perhaps all post-2003,</p> <p>21 don't tell us anything about -- about what was</p> <p>22 going on in the mine during the period of time</p> <p>23 when it was being used to source talc?</p> <p>24 A No. That part of the mine is gone.</p>	<p style="text-align: right;">Page 501</p> <p>1 Object to the form.</p> <p>2 MR. FERGUSON:</p> <p>3 Q And what was the time frame for those</p> <p>4 photographs?</p> <p>5 A I've got them in my report.</p> <p>6 Q Okay.</p> <p>7 A I don't remember the exact dates. But</p> <p>8 they're -- each photograph I've -- I've tried to</p> <p>9 give a date on.</p> <p>10 Q Okay. So how long had that mine been</p> <p>11 being mined for purposes of cosmetic talc before</p> <p>12 2003? Do you know?</p> <p>13 A It's an old mine. It was originally an</p> <p>14 underground mine. And I think that probably as</p> <p>15 long as the West Windsor mill had been in</p> <p>16 operation there had been some cosmetic talc</p> <p>17 coming out of Argonaut.</p> <p>18 Q So it's been mined for years and years</p> <p>19 and years; correct?</p> <p>20 A I think so.</p> <p>21 Q Okay. And the five to ten photographs</p> <p>22 that you looked at, how long does it take to take</p> <p>23 a photograph? Something less than a second?</p> <p>24 MS. O'DELL:</p>

<p style="text-align: right;">Page 502</p> <p>1 Object to the form.</p> <p>2 A Yes. But --</p> <p>3 MR. FERGUSON:</p> <p>4 Q Okay. So -- so those photographs were</p> <p>5 showing you what the mine looked like during the</p> <p>6 millisecond it took to take each of those</p> <p>7 photographs; correct?</p> <p>8 MS. O'DELL:</p> <p>9 Object to the form.</p> <p>10 A Yeah. That's -- that's sort of a</p> <p>11 loaded question, because what you see in the</p> <p>12 photographs is the -- the result of mining over a</p> <p>13 period of time. Sure.</p> <p>14 You've got a photograph. I mean,</p> <p>15 everybody knows it doesn't take very long to take</p> <p>16 a photograph. But if you're taking a photograph</p> <p>17 of a mine that is -- that is full of shot rock</p> <p>18 and waste rock and benches that are -- have been</p> <p>19 covered with -- with material that I wouldn't</p> <p>20 think should be there if you were selectively</p> <p>21 mining a higher-grade deposit, then the -- the</p> <p>22 little millisecond that it takes to take that</p> <p>23 photograph is capturing a condition that probably</p> <p>24 represents a number of years.</p>	<p style="text-align: right;">Page 504</p> <p>1 A Well, it might. But I'd say that the</p> <p>2 odds are that in that -- in the hour preceding</p> <p>3 when the aerial photograph was taken, there</p> <p>4 wouldn't have been a shot, because these</p> <p>5 photographs were not taken by, you know, some</p> <p>6 tourist flying over. These are aerial</p> <p>7 photographs that were apparently taken by</p> <p>8 Johnson & Johnson or probably Imerys personnel to</p> <p>9 document the condition of the mine at that point.</p> <p>10 It's very common to do this, because that's one</p> <p>11 of the ways that you can -- can measure your</p> <p>12 stockpiles is -- is by overflights.</p> <p>13 Q Do you know who took them?</p> <p>14 A No, I don't know who took them. It may</p> <p>15 have said somewhere in the document.</p> <p>16 They came out of -- they came out of --</p> <p>17 I think some of them actually came out of a</p> <p>18 Luzenac document.</p> <p>19 Q And you don't know, yourself, what</p> <p>20 occurred, whether there had been a blast in the</p> <p>21 previous hour, two hours?</p> <p>22 A No. What I was gonna say was if it was</p> <p>23 gonna be a blast that day, I don't think I would</p> <p>24 have been up in a plane over the quarry.</p>
<p style="text-align: right;">Page 503</p> <p>1 Q But when you took the photo -- when you</p> <p>2 looked at the photographs, they represented only</p> <p>3 a very, very short span of time in a -- in a mine</p> <p>4 that's been mined for years and years and years;</p> <p>5 correct?</p> <p>6 MS. O'DELL:</p> <p>7 Object to the form.</p> <p>8 A That's what I'm saying is it may not</p> <p>9 represent a short span of time. If you take a</p> <p>10 look at the photographs, it should be pretty</p> <p>11 obvious to you that the mines are not -- they're</p> <p>12 not -- I wouldn't call them clean. There's an</p> <p>13 awful lot of rock that is scattered about that --</p> <p>14 that you wouldn't see if you were selectively</p> <p>15 mining rock to make sure that you weren't getting</p> <p>16 bad material mixed in with good.</p> <p>17 MR. FERGUSON:</p> <p>18 Q And do you know what had been going on</p> <p>19 immediately in the previous hour or so before the</p> <p>20 photograph was taken?</p> <p>21 A It would look exactly like the</p> <p>22 photograph. I mean, mining doesn't -- it</p> <p>23 isn't -- unless they had shot off a blast.</p> <p>24 Q Okay. That happens, doesn't it?</p>	<p style="text-align: right;">Page 505</p> <p>1 Q Okay. And have you talked to whoever</p> <p>2 took the plane to take the pictures?</p> <p>3 MS. O'DELL:</p> <p>4 Object to the form.</p> <p>5 A I have no idea who took the pictures.</p> <p>6 MR. FERGUSON:</p> <p>7 Q That's all. Thank you, sir.</p> <p>8 A Sure.</p> <p>9 MS. O'DELL:</p> <p>10 I have nothing further, Doctor.</p> <p>11 MR. FROST:</p> <p>12 I have a real quick follow-up on those</p> <p>13 questions.</p> <p>14 MS. O'DELL:</p> <p>15 I may have something further, but not</p> <p>16 after Mr. Ferguson.</p> <p>17 EXAMINATION</p> <p>18 BY MR. FROST:</p> <p>19 Q All right, sir. Look at page 8 of your</p> <p>20 report, that picture.</p> <p>21 A Right.</p> <p>22 Q So is the airplane parked on the</p> <p>23 ground?</p> <p>24 A No. The aerial photographs are in the</p>

<p style="text-align: right;">Page 506</p> <p>1 exhibit in the back.</p> <p>2 Q Okay. Let's turn to the exhibit in the</p> <p>3 back.</p> <p>4 A Yeah.</p> <p>5 Q Would you agree with me that only two</p> <p>6 of these pictures actually appear to be aerial</p> <p>7 photos of the mine?</p> <p>8 A Right. Sure.</p> <p>9 Q Okay. The rest of the one, two, three,</p> <p>10 four, five --</p> <p>11 A They illustrate exactly what I was</p> <p>12 talking about.</p> <p>13 Q Well, again, my question is only two of</p> <p>14 the photographs are aerial; correct?</p> <p>15 A Sure.</p> <p>16 Q The other five appear to be taken from</p> <p>17 the ground?</p> <p>18 MS. O'DELL:</p> <p>19 Just count them. Don't agree if you</p> <p>20 don't --</p> <p>21 A No.</p> <p>22 MR. FROST:</p> <p>23 Q Well, you can count them, but it's</p> <p>24 five.</p>	<p style="text-align: right;">Page 508</p> <p>1 C E R T I F I C A T E</p> <p>2 STATE OF ALABAMA)</p> <p>3 COUNTY OF MOBILE)</p> <p>4</p> <p>5 I do hereby certify that the above and</p> <p>6 foregoing transcript of proceedings in the matter</p> <p>7 aforementioned was taken down by me in machine</p> <p>8 shorthand, and the questions and answers thereto</p> <p>9 were reduced to writing under my personal</p> <p>10 supervision, and that the foregoing represents a</p> <p>11 true and correct transcript of the proceedings</p> <p>12 given by said witness upon said hearing.</p> <p>13 I further certify that I am neither of</p> <p>14 counsel nor of kin to the parties to the action,</p> <p>15 nor am I in anywise interested in the result of</p> <p>16 said cause.</p> <p>17 Signed this 2nd day of February, 2019.</p> <p>18</p> <p>19</p> <p>20</p> <p>21 LOIS ANNE ROBINSON, RDR</p> <p>22 COURT REPORTER, NOTARY PUBLIC</p> <p>23 STATE OF ALABAMA AT LARGE</p> <p>24 ACCR# 352; EXPIRES 9/30/19</p>
<p style="text-align: right;">Page 507</p> <p>1 A But since you've pointed out that not</p> <p>2 all of them were from the air, the last</p> <p>3 photograph was from the ground because the plane</p> <p>4 was grounded because of snow.</p> <p>5 Q Sure. There we go.</p> <p>6 All right. That's all the questions I</p> <p>7 have, sir.</p> <p>8 MS. O'DELL:</p> <p>9 I have nothing further.</p> <p>10 VIDEOGRAPHER:</p> <p>11 We're off the record. The time is</p> <p>12 7:20 p.m.</p> <p>13 (DEPOSITION EXHIBITS 34-1 TO 34-13,</p> <p>14 35, 36, 37, 38, AND 39 WERE MARKED</p> <p>15 FOR IDENTIFICATION.)</p> <p>16 (Deposition concluded at 7:20 p.m.)</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p>	<p style="text-align: right;">Page 509</p> <p>1 E R R A T A P A G E</p> <p>2</p> <p>3 I, ROBERT COOK, Ph.D., the witness</p> <p>4 herein, have read the transcript of my testimony,</p> <p>5 and the same is true and correct, to the best of my</p> <p>6 knowledge, with the exceptions of the following</p> <p>7 changes noted below, if any:</p> <p>8 Page/Line Word/Words to be changed Correct Word</p> <p>9 _____</p> <p>10 _____</p> <p>11 _____</p> <p>12 _____</p> <p>13 _____</p> <p>14 _____</p> <p>15 _____</p> <p>16 _____</p> <p>17 _____</p> <p>18 _____</p> <p>19 _____</p> <p>20 _____</p> <p>21 _____</p> <p>22 _____</p> <p>23 _____</p> <p>24 _____</p> <p>25 _____</p> <p>26 _____</p> <p>27 _____</p> <p>28 _____</p> 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DECLARATION OF WITNESS

I, the undersigned, declare under penalty
of perjury that I have read the foregoing
transcript, and I have made any corrections,
additions, or deletions that I was desirous of
making; that the foregoing is a true and correct
transcript of my testimony contained herein.

EXECUTED this _____ day of _____,
2019, at _____, _____.
(City) (State)

ROBERT COOK, Ph.D.

Exhibit 47

1 IN THE UNITED STATES DISTRICT COURT
2 FOR THE DISTRICT OF NEW JERSEY
3
4 _____
5 : :
6 IN RE: JOHNSON & JOHNSON : MDL NO. 2592
7 TALCUM POWDER PRODUCTS : 16-2738 (FLW) (LGH)
8 MARKETING, SALES PRACTICES :
9 AND PRODUCTS LIABILITY :
10 LITIGATION :
11 :
12 THIS DOCUMENT RELATES TO: :
13 ALL CASES :
14 :
15 :

Videotaped Deposition of
MARK KREKELER, Ph.D.

Taken: By the Defendants
Pursuant to Notice

Date: January 25, 2019

Time: Commencing at 9:16 a.m.

Place: Hampton Inn
375 South College Avenue
Oxford, Ohio 45056

Before: Susan M. Gee, RMR, CRR
Notary Public - State of Ohio
and
Melinda Sindiong, CLVS

Page 2										Page 4									
1 APPEARANCES:										1 I N D E X									
2										2									
3 On behalf of the Plaintiffs:										3 WITNESS: MARK KREKELER, Ph.D.									
4 BEASLEY ALLEN LAW FIRM										4 PAGE									
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6 BY: JENNIFER K. EMMEL, ESQ.										6 By Mr. Frost 8									
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16 (843) 216-9160										16 NUMBER DESCRIPTION PAGE									
17 cscott@motleyrice.com										17 1 11/16/18 Rule 26 Expert Report of 13									
18										18 Mark Krekeler, Ph.D.									
19 WILENTZ, GOLDMAN & SPITZER, P.A.										19 2 1/17/19 Rule 26 Addendum to the 13									
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23 Woodbridge, New Jersey 07095										23									
24 (732) 865-6066										24 4 IC 8757 Bureau of Mines Information 86									
25 dlapinski@wilentz.com										25 Circular/1977									
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17 DRINKER BIDDLE & REATH LLP										27 Carcinogenic Risks to Humans, Vol. 93									
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20 Florham Park, New Jersey 07932										30 Circular/1977									
21 (873) 549-7338										31 5 IARC Monographs on the Evaluation of 91									
22 jack.frost@dbr.com										32 Carcinogenic Risks to Humans, Vol. 93									
23 SKADDEN, ARPS, SLATE, MEAGHER & FLOM										33									
24 BY: NINA R. ROSE, ESQ.										34 6 U.S. Department of Health and Human 109									
25 1440 New York Avenue, N.W.										35 Services Toxicological Profile for									
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<p>1 EXHIBITS</p> <p>2 NUMBER DESCRIPTION PAGE</p> <p>3 18 Preliminary Investigation of Cosmetic 188</p> <p>4 Talc Potential, Lungsheng Operations,</p> <p>5 Kwangsi, China</p> <p>6 Bates JNINL61_000002060 - 89</p> <p>7</p> <p>8 19 Sampling of Run-of-mine mill feed - 209</p> <p>9 A practical approach</p> <p>10 by Afewu and Lewis</p> <p>11</p> <p>12 20 Email dated 10/31/13 218</p> <p>13 Bates JNJ14T5_000005157 - 48</p> <p>14 21 Zuffar Days Symposium Held in Cagliari 236</p> <p>15 October 10 - 15, 1988</p> <p>16 Geology of the Italian high quality</p> <p>17 cosmetic talc from the Pinerolo district</p> <p>18 (Western Alps) by Sandrone and Zucchetti</p> <p>19 22 Krekeler Deposition Asbestos Documents 240</p> <p>20 Various Bates numbers</p> <p>21</p> <p>22 23 An Introduction to the Rock-Forming 285</p> <p>23 Materials by Deer, Howie & Zussman</p> <p>24 24 The Mineral Industry of Italy by 288</p> <p>25 by Harold R. Newman</p> <p>26</p> <p>27 25 Analysis of an Authentic Historical 289</p> <p>28 Italian Cosmetic Talc Sample - Further</p> <p>29 Evidence for he Lack of Cancer Risk</p> <p>30</p> <p>31 26 Excerpt from the Deposition of Patrick 291</p> <p>32 Downey taken 11/8/17</p> <p>33 27 FDA Action Related to Talc 297</p> <p>34 28 USB Jump Drive 331</p> <p>35 29 Color Photograph 331</p> <p>36 30 Color Photograph 331</p> <p>37 - - -</p> <p>38</p> <p>39</p>	<p>1 Rees, for Imerys.</p> <p>2 MR. CARY: Andrew Cary, Gordon & Rees,</p> <p>3 for Imerys.</p> <p>4 MR. NAEEM: Tariq Naeem, Tucker Ellis,</p> <p>5 for the Pharmatech defendants.</p> <p>6 MR. BILLINGS-KANG: James Billings-Kang</p> <p>7 for Personal Care Products Council.</p> <p>8 VIDEOGRAPHER: The court reporter is</p> <p>9 Susan Gee, RMR and CRR, and will now swear in</p> <p>10 the witness, and we can proceed.</p> <p>11 MARK KREKELER, Ph.D.</p> <p>12 of lawful age, a witness herein, being first duly sworn</p> <p>13 as hereinafter certified, was examined and deposed as</p> <p>14 follows:</p> <p>15 CROSS-EXAMINATION</p> <p>16 BY MR. FROST:</p> <p>17 Q. Good morning, Dr. Krekeler. My name is</p> <p>18 Jack Frost. I'll be asking you probably the majority of</p> <p>19 the questions today.</p> <p>20 A. Okay.</p> <p>21 Q. But before we get started, could you</p> <p>22 please state your full name for the record?</p> <p>23 A. Mark Paul Spigg Krekeler.</p> <p>24 Q. And where do you currently work?</p> <p>25 A. I am an associate professor at Miami</p>
Page 7	Page 9
<p>1 VIDEOGRAPHER: We are now on the record.</p> <p>2 My name is Melinda Sindiong, CLVS. I'm</p> <p>3 videographer for Golkow Litigation Services.</p> <p>4 Today is January 25th, 2019. The time is 9:16.</p> <p>5 The video deposition is being held in Oxford,</p> <p>6 Ohio, in the matter of Johnson & Johnson Talcum</p> <p>7 Powder Products Marketing Sales Liability</p> <p>8 Litigation. This is for the United States</p> <p>9 District Court of the District of New Jersey.</p> <p>10 The deponent is Mark Krekeler, M.D.</p> <p>11 Will counsel please identify yourselves</p> <p>12 and the parties you represent?</p> <p>13 MS. SCOTT: My name is Carmen Scott. I'm</p> <p>14 with Motley Rice, for the plaintiffs.</p> <p>15 MS. O'DELL: Leigh O'Dell, Beasley Allen,</p> <p>16 for the plaintiffs.</p> <p>17 MS. EMMEL: Jennifer Emmel, Beasley</p> <p>18 Allen, for the plaintiffs.</p> <p>19 MR. LAPINSKI: Daniel Lapinski, Wilentz</p> <p>20 law firm, for the plaintiffs.</p> <p>21 MR. FROST: Jack Frost, Drinker Biddle &</p> <p>22 Reath, on behalf of Johnson & Johnson.</p> <p>23 MS. ROSE: Nina Rose, Skadden, Arps, on</p> <p>24 behalf of Johnson & Johnson.</p> <p>25 MR. FERGUSON: Ken Ferguson, Gordon &</p>	<p>1 University. I hold an appointment where my tenure is</p> <p>2 held on the Oxford campus in the department of geology,</p> <p>3 and my teaching the -- I work at the Hamilton campus as</p> <p>4 well.</p> <p>5 Q. And just so the record is clear, Miami</p> <p>6 University, there are two. We're at the one in Ohio,</p> <p>7 right?</p> <p>8 A. To my knowledge, there's only one Miami</p> <p>9 University.</p> <p>10 Q. The other one's University of?</p> <p>11 A. Yes.</p> <p>12 Q. Okay. All right.</p> <p>13 A. Miami was founded in 1809.</p> <p>14 Q. And have you ever been deposed before?</p> <p>15 A. No, I have not been deposed before.</p> <p>16 Q. Okay. Have you ever testified before?</p> <p>17 A. No, I have not testified before.</p> <p>18 Q. All right. Real quick, I'll go over some</p> <p>19 ground rules. I'm sure your counsel has told you this,</p> <p>20 but the number one most important thing is everything</p> <p>21 we're saying today is being written down by the court</p> <p>22 reporter who's to my left. So because of that, we have</p> <p>23 to make sure we verbalize everything. Uh-huh, huh-uh,</p> <p>24 nods of the head, pointing, things like that don't show</p> <p>25 up very well in written word.</p>

<p>Page 10</p> <p>1 A. Very good.</p> <p>2 Q. So we just need to make sure that, you</p> <p>3 know, we're verbalizing everything.</p> <p>4 Second thing is, and I guarantee we'll</p> <p>5 get in trouble for this at some point. It's very hard</p> <p>6 for the court reporter to write down when both of us are</p> <p>7 talking at the same time. I'm not saying we're doing it</p> <p>8 in a rude way but just normal human conversation.</p> <p>9 Eventually, you'll pick up what the end of my question</p> <p>10 is. I'll pick up the end of your answer, and we'll just</p> <p>11 start naturally talking over each other. We've got to</p> <p>12 be really careful about that, you know, make sure she</p> <p>13 can write it down.</p> <p>14 At some points during the deposition,</p> <p>15 your counsel may object or other people in the room may</p> <p>16 object. Allow time to give counsel, you know, to put</p> <p>17 their objections on. Once they're done, unless you're</p> <p>18 instructed otherwise by your counsel, you have to answer</p> <p>19 my question.</p> <p>20 The other thing is, if you answer my</p> <p>21 question, I'm going to understand you assumed it or</p> <p>22 understood it. So if you don't understand what I'm</p> <p>23 asking, you need clarification, let me know. If there</p> <p>24 is, you know, something you need for me to work out, I'd</p> <p>25 rather work it out than have you answer something that,</p>	<p>Page 12</p> <p>1 just say it again and agree on it or -- I'm unclear.</p> <p>2 I've never done this before.</p> <p>3 BY MR. FROST:</p> <p>4 Q. Sure. So to the extent we can, just</p> <p>5 listen to my question and answer the question, yeah, as</p> <p>6 I've asked it. What shows up on the screen is called</p> <p>7 phonetic, so sometimes the words converted over by the</p> <p>8 computer will be incorrect, and ultimately, when they</p> <p>9 come and transfer it for the final transcript, it will</p> <p>10 change.</p> <p>11 So these are sort of there as a guide, if</p> <p>12 we can't remember what we're talking about a couple</p> <p>13 minutes ago, to look back. But this is not the official</p> <p>14 record. The official record will be what's on the</p> <p>15 video, and then, ultimately, what's in the transcript,</p> <p>16 which might end up being a little different than what's</p> <p>17 on the screen.</p> <p>18 A. Okay. And because -- so a third party</p> <p>19 would go and transcribe what's on the video?</p> <p>20 Q. So I'm not sure at the end, yeah.</p> <p>21 A. So if there's something garbled on here,</p> <p>22 someone else does that?</p> <p>23 Q. Yes. That's correct.</p> <p>24 A. So they don't come back to me or --</p> <p>25 Q. No. You don't need to worry about that.</p>
<p>Page 11</p> <p>1 you know, you and I are talking at different places.</p> <p>2 The only other thing, too, I don't want</p> <p>3 you to guess here today, and if you're guessing or</p> <p>4 making an estimate, just let us know. And, you know,</p> <p>5 but if it's a wild guess, I don't know, I don't</p> <p>6 remember, those are perfectly fine answers.</p> <p>7 And other than that, if you need a break</p> <p>8 at any time, let us know. If there's a question</p> <p>9 pending, you've got to answer the question first, but</p> <p>10 we're here on your schedule, so -- and we'll try to</p> <p>11 break every hour, hour and a half or so, but if you need</p> <p>12 to break in between, you know, just let us know, and</p> <p>13 we'll stop.</p> <p>14 A. Can I ask a question?</p> <p>15 Q. Sure.</p> <p>16 A. So I've never done this before. I've</p> <p>17 never been deposed, and I noticed early on, when the</p> <p>18 videographer was making some statements, that the</p> <p>19 statements that I heard were not recorded accurately on</p> <p>20 this. So the word was "demotion."</p> <p>21 MS. SCOTT: You don't need to worry about</p> <p>22 that.</p> <p>23 A. So but my question is, is if I go -- if I</p> <p>24 use this to read your question, how do I know a word's</p> <p>25 not -- how do we make sure that word is right? Do we</p>	<p>Page 13</p> <p>1 That's done somewhere else.</p> <p>2 A. Okay. Yeah. I don't -- I don't know.</p> <p>3 Q. No. That's okay. It's a fair question.</p> <p>4 But --</p> <p>5 VIDEOGRAPHER: Sorry. If I can interject</p> <p>6 as well, you're talking with your hands, and it</p> <p>7 does get in the shot.</p> <p>8 MR. FROST: Oh, mine does?</p> <p>9 VIDEOGRAPHER: Yes.</p> <p>10 THE WITNESS: Okay. Sorry.</p> <p>11 VIDEOGRAPHER: Thank you.</p> <p>12 MR. FROST: All right. So if I can mark</p> <p>13 a couple exhibits to begin. I'll mark this as</p> <p>14 Exhibit 1.</p> <p>15 (Exhibit 1 was marked for</p> <p>16 identification.)</p> <p>17 MR. FROST: I'll mark this as Exhibit 2.</p> <p>18 THE WITNESS: Does it matter which copy?</p> <p>19 MS. SCOTT: You can take a look at</p> <p>20 whichever you're more comfortable with. They're</p> <p>21 the same.</p> <p>22 MR. FROST: I imagine they're the same,</p> <p>23 right?</p> <p>24 (Exhibit 2 was marked for</p> <p>25 identification.)</p>

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<p>1 BY MR. FROST:</p> <p>2 Q. All right. In front of you marked as</p> <p>3 Exhibits 1 and 2 are your expert report that's dated</p> <p>4 November 16th, 2018, and then Exhibit 2 is your</p> <p>5 supplemental report dated January 17th, 2019; is that</p> <p>6 correct?</p> <p>7 A. Yes.</p> <p>8 Q. Are these the only two reports that</p> <p>9 you've written in this case?</p> <p>10 A. Yes.</p> <p>11 Q. Now, you understand you've been</p> <p>12 designated by the plaintiffs in this case in the Johnson</p> <p>13 & Johnson talc MDL?</p> <p>14 A. Yes.</p> <p>15 Q. Okay. Can you explain to me what, or</p> <p>16 define what your area of expertise is?</p> <p>17 A. Yes. So my undergraduate degree was in</p> <p>18 geology, and since my freshman year, I've been working</p> <p>19 with clay materials and clay intervals. My degree is</p> <p>20 in -- my undergraduate degree is a bachelor's of science</p> <p>21 in geology, and so that entailed field work. And,</p> <p>22 actually, I think since my freshman year, I've been</p> <p>23 doing powder x-ray diffraction. My master's was on,</p> <p>24 also, a clay rich rock, bentonite, so -- and then in --</p> <p>25 I finished that degree in '98.</p>	<p>1 phyllosilicates as well. And, basically, I worked with</p> <p>2 industrial mineral materials, mine materials, and then</p> <p>3 my time at Miami University, I've also worked with</p> <p>4 synthetic minerals and natural minerals.</p> <p>5 So my training as a Ph.D. student was to</p> <p>6 look at the phyllosilicate minerals as a whole. So</p> <p>7 mineralogy has evolved significantly in that we think of</p> <p>8 minerals as sort of a system, and we look at things at</p> <p>9 how they're interrelated. And that's -- so, basically,</p> <p>10 I've had some -- my degree is in geotechnical</p> <p>11 engineering and environmental earth science, so I have a</p> <p>12 few engineering classes. And then I've collaborated and</p> <p>13 worked with several mineral companies. My Ph.D. was</p> <p>14 sponsored by a mineral company, in part.</p> <p>15 Q. So long story short, would you define</p> <p>16 your area of expertise as mineralogy?</p> <p>17 A. Yes.</p> <p>18 Q. Okay. And the two reports in front of</p> <p>19 you, do those reflect all the opinions you plan to give</p> <p>20 in this case or intend to give in this case?</p> <p>21 A. Well, again, I'm legally not familiar</p> <p>22 with the process, but I think I -- currently, this is my</p> <p>23 opinions. If something new comes up and I'm asked, I</p> <p>24 would...</p> <p>25 Q. Okay. I guess a better way to ask that</p>
Page 15	Page 17
<p>1 Then my Ph.D. was in mineralogy and</p> <p>2 specifically phyllosilicate mineralogy and looking at</p> <p>3 the impurities and materials associated with</p> <p>4 phyllosilicates. My dissertation was on</p> <p>5 palygorskite-sepiolite minerals and smectite minerals.</p> <p>6 My Ph.D. advisor was Steve Guggenheim, who essentially</p> <p>7 is the North American expert in crystallography for</p> <p>8 phyllosilicates.</p> <p>9 And, then, so I finished that degree in</p> <p>10 2003. Throughout my degrees, I think my first</p> <p>11 consulting job was a project with Amoco when I was an</p> <p>12 undergrad doing x-ray diffraction, looking at clays from</p> <p>13 Trinidad through my advisor, Warren Huff. But through</p> <p>14 that period of time, I did occasional consulting</p> <p>15 projects, largely with powder x-ray diffraction and</p> <p>16 sometimes electron microscopy.</p> <p>17 Then I did not do a postdoc. There were</p> <p>18 two mineralogy positions available nationwide when I</p> <p>19 graduated. My graduation year was 2003. I then got one</p> <p>20 of those positions at George Mason University, and I was</p> <p>21 hired in a department of environmental science and</p> <p>22 policy. And my research there, I was specifically</p> <p>23 teaching mineralogy. Then my research was centered</p> <p>24 around mineralogy.</p> <p>25 I produced a few patents relating to</p>	<p>1 question --</p> <p>2 A. Sorry. I'm unclear. I'm not familiar.</p> <p>3 Q. Yeah. That's okay. As we sit here</p> <p>4 today, do you intend to offer any opinions in this case</p> <p>5 that aren't reflected in either of these two reports?</p> <p>6 A. No. The reports are what I am using.</p> <p>7 Q. And were you asked to render any reports</p> <p>8 by your counsel that you did not or are not included in</p> <p>9 those reports?</p> <p>10 MS. SCOTT: Objection. You can answer.</p> <p>11 BY MR. FROST:</p> <p>12 Q. You can answer.</p> <p>13 A. Oh, I can answer? So, if I remember</p> <p>14 correctly, with the deposition notice, it was requested</p> <p>15 that reports or documents I prepared relating to, I</p> <p>16 think, all talc cases were requested. So there's one</p> <p>17 report that I gave to them from another case that I'm</p> <p>18 involved in.</p> <p>19 Q. Okay. So you're currently involved in</p> <p>20 another talc case or is this an older case?</p> <p>21 A. This is a current case.</p> <p>22 Q. And it's a talc case?</p> <p>23 A. It is a talc-related case, yes.</p> <p>24 Q. Is it a case against Johnson & Johnson?</p> <p>25 A. I believe it's a case against Imerys.</p>

<p style="text-align: right;">Page 18</p> <p>1 Q. Against Imerys? Do you know what the 2 case is called or where it's venued?</p> <p>3 A. I don't remember offhand. The law firm 4 is Waters & Kraus.</p> <p>5 Q. That's who retained you?</p> <p>6 A. Yes.</p> <p>7 Q. Do you know what state it's in?</p> <p>8 A. The law firm is in Texas. I think the 9 case is in Texas.</p> <p>10 Q. And what have you been asked to do in 11 that case?</p> <p>12 MS. SCOTT: I'm going to object to the 13 extent that I'm not aware of what his role is in 14 that case.</p> <p>15 MR. FROST: Sure.</p> <p>16 MS. SCOTT: And I'm not sure he knows 17 what's going on and, you know, the extent of 18 the -- whether he's been disclosed in that case 19 or not.</p> <p>20 MR. FROST: Okay.</p> <p>21 MS. SCOTT: So I'm going to object to any 22 questions on that.</p> <p>23 MR. FROST: All right. We'll reserve our 24 right to come back.</p> <p>25 MS. SCOTT: Sure.</p>	<p style="text-align: right;">Page 20</p> <p>1 cite throughout the report?</p> <p>2 A. Yes.</p> <p>3 Q. The piece of literature, things like 4 that?</p> <p>5 A. Yes.</p> <p>6 Q. Okay. Other than documents, books, 7 literature, et cetera, that are already included in your 8 report, have you brought anything else with you today?</p> <p>9 A. No. I believe just what is in the 10 report.</p> <p>11 Q. Okay. We're also going to probably send 12 a request for, you know, a copy of the report written on 13 the other case as well. It seems like it was turned 14 over to counsel.</p> <p>15 MS. O'DELL: No. You misunderstood. 16 It's not been turned over to counsel.</p> <p>17 MR. FROST: It hasn't been turned over to 18 you guys.</p> <p>19 MS. O'DELL: We don't have any 20 information about that case.</p> <p>21 MR. FROST: Oh, okay.</p> <p>22 MS. O'DELL: Yeah. So if you have any 23 questions about that, you need to talk to Waters 24 & Kraus or whoever else is involved.</p> <p>25</p>
<p style="text-align: right;">Page 19</p> <p>1 BY MR. FROST:</p> <p>2 Q. Have you brought that report that you 3 drafted in that case with you today?</p> <p>4 A. I don't know.</p> <p>5 Q. Okay. Did you bring anything with you -- 6 I'll start. So there seems to be a table of stuff next 7 to you. Is that a fair way to describe that?</p> <p>8 A. Yes.</p> <p>9 Q. And what, generally, is that stuff? Like 10 what's in the binders and things like that?</p> <p>11 A. So, generally, those are documents that 12 were provided when I requested them, and those documents 13 are from the companies.</p> <p>14 Q. Are those all the documents that are 15 listed in your materials-relied-upon list at the end of 16 your report?</p> <p>17 A. Yes.</p> <p>18 Q. Is there anything in those binders that 19 isn't otherwise reflected on the list in your reports?</p> <p>20 A. I'm sorry?</p> <p>21 Q. I can reask it if it's easier.</p> <p>22 A. Is there anything in those binders that 23 isn't otherwise reflected on the list? I have books 24 that are also included in the report.</p> <p>25 Q. Okay. Those are the various books you</p>	<p style="text-align: right;">Page 21</p> <p>1 BY MR. FROST:</p> <p>2 Q. So before, when you said you'd given the 3 report to counsel, you're talking about Waters & Kraus, 4 not --</p> <p>5 A. I don't recall specifics.</p> <p>6 Q. All right. Have you turned that report 7 at all over to any of your attorneys who are here today 8 or anybody who works for them, their law firms, if you 9 can recall?</p> <p>10 A. I don't remember specifics.</p> <p>11 Q. Okay. Do you recall when you were 12 retained in that case?</p> <p>13 A. In the other case?</p> <p>14 Q. Yes.</p> <p>15 A. It was about the same time as this case.</p> <p>16 Q. Do you recall when that was?</p> <p>17 A. Basically, I want to say it was towards 18 the end of December of 2017, but -- so that's when we 19 talked, and then I think it was like late January, maybe 20 February, when I actually started reviewing documents 21 for that case.</p> <p>22 Q. Have you generated any invoices for your 23 work in this case yet?</p> <p>24 A. I'm sorry. Are you referring to --</p> <p>25 Q. For this, what we're here for today, the</p>

<p style="text-align: right;">Page 22</p> <p>1 Johnson & Johnson MDL case.</p> <p>2 A. Yes. I'm up to date with invoices.</p> <p>3 Q. And did you bring any of those invoices</p> <p>4 with you?</p> <p>5 MS. SCOTT: Counsel, those were provided</p> <p>6 previously about a week ago by email.</p> <p>7 MR. FROST: All right.</p> <p>8 BY MR. FROST:</p> <p>9 Q. But other than that, there's nothing, no</p> <p>10 additional documents or invoices?</p> <p>11 A. Right. There's no outstanding billing or</p> <p>12 anything --</p> <p>13 Q. Yeah.</p> <p>14 A. -- like that.</p> <p>15 Q. Okay.</p> <p>16 A. Yeah. We're all caught up.</p> <p>17 Q. All right. Turning back to the reports</p> <p>18 that are in front of you as Exhibits 1 or 2, are these</p> <p>19 reports complete, as far as you're concerned?</p> <p>20 A. To the best of my knowledge, they're</p> <p>21 complete, based on what I was provided to review.</p> <p>22 Q. And do you believe what's reflected in</p> <p>23 those reports is accurate?</p> <p>24 A. I believe that my opinions are accurate.</p> <p>25 The data as presented as findings are as they are</p>	<p style="text-align: right;">Page 24</p> <p>1 A. Is it fair to say that, effectively, the</p> <p>2 opinions you're rendering here are limited to review of</p> <p>3 the geologic deposits utilized by Johnson & Johnson</p> <p>4 and -- it's kind of garbled.</p> <p>5 Q. Yeah. And Imerys.</p> <p>6 A. And to create talcum powder. So, yes, I</p> <p>7 reviewed those materials.</p> <p>8 Q. Okay. And you're not here to opine about</p> <p>9 anything outside of those geological deposits and the</p> <p>10 mining practices, et cetera, that were going on at those</p> <p>11 areas?</p> <p>12 MS. SCOTT: Objection.</p> <p>13 A. So the nature of mineralogy, as I alluded</p> <p>14 to earlier, is very systematic, right? So it's not the</p> <p>15 same deposit. It's not the same deposit, but there's</p> <p>16 Caledonia. New Caledonia is a terrain that has a lot of</p> <p>17 talc in it, that has a lot of nickel in it, and so,</p> <p>18 essentially, the geologic knowledge as a whole,</p> <p>19 essentially, I'm relying on my educational base, my</p> <p>20 research base, things like that. So being aware of the</p> <p>21 geology of talc and the mineralogy of talc, geochemistry</p> <p>22 of talc through global settings is critical to evaluate</p> <p>23 any subset of data relating to talc and associated</p> <p>24 rocks.</p> <p>25</p>
<p style="text-align: right;">Page 23</p> <p>1 interpreted by the company. So when you say -- again,</p> <p>2 I'm unexperienced.</p> <p>3 Q. Sure.</p> <p>4 A. So when you say "accurate," I don't think</p> <p>5 some of the report, some of the findings are</p> <p>6 scientifically accurate, based on the analytical</p> <p>7 methods. So...</p> <p>8 Q. Are you talking about some of your</p> <p>9 findings? I'm asking sort of what your ultimate</p> <p>10 opinions and your findings in this case. Do you believe</p> <p>11 that what you've opined to in this case is accurate in</p> <p>12 these reports?</p> <p>13 A. So is my opinion --</p> <p>14 Q. Yes.</p> <p>15 A. -- accurate?</p> <p>16 Q. Yes.</p> <p>17 A. Yes, I believe my opinion is accurate.</p> <p>18 Q. Is there anything, before we get started</p> <p>19 going through those opinions, that you want to change or</p> <p>20 amend?</p> <p>21 A. No.</p> <p>22 Q. And is it fair to say that, effectively,</p> <p>23 the opinions you're rendering here are limited to review</p> <p>24 of the geologic deposits utilized by Johnson & Johnson</p> <p>25 and Imerys to create talcum powder?</p>	<p style="text-align: right;">Page 25</p> <p>1 BY MR. FROST:</p> <p>2 Q. I'll ask it a sort of different way.</p> <p>3 I'll break it down. You didn't do any testing here of</p> <p>4 any product, right?</p> <p>5 A. I was not asked to do any testing.</p> <p>6 Q. Okay. And you're not going to render any</p> <p>7 opinions about what causes disease, anything of that</p> <p>8 nature?</p> <p>9 A. Correct. I am not a medical expert. I</p> <p>10 am not an environmental health expert.</p> <p>11 Q. And you're not going to render any</p> <p>12 opinions about what level of exposure to any particular</p> <p>13 metal or contaminate can cause disease?</p> <p>14 A. Again, I would defer for details to</p> <p>15 environmental health experts and medical experts.</p> <p>16 Q. You're not going to render any opinion</p> <p>17 that use of Johnson & Johnson talcum powder causes</p> <p>18 ovarian cancer, right?</p> <p>19 A. So I'm sorry. I am not an expert in the</p> <p>20 molecular mechanisms of carcinogenicity, if I said that</p> <p>21 correct. I don't know. I'm not a medical person. So,</p> <p>22 no.</p> <p>23 Q. All right. Looking at Exhibit 2, which</p> <p>24 is the addendum report, why did you draft this addendum?</p> <p>25 A. New materials became available.</p>

<p style="text-align: right;">Page 26</p> <p>1 Q. When were you asked to draft the 2 addendum?</p> <p>3 A. I think when Longo had his supplemental, 4 and then I can't remember exactly when, but what really 5 caught my eye was this testing where they used 6 .1 milligrams of a sample, and that's not representative 7 in any way, and then they use a silver membrane.</p> <p>8 Q. I'll stop you here, because we'll be here 9 for a very long time.</p> <p>10 A. Okay.</p> <p>11 Q. So the question was: When were you asked 12 to draft the report?</p> <p>13 A. I'm sorry. I'm sorry. You're right. I 14 got distracted. It was in January sometime.</p> <p>15 Q. And if you look at the second paragraph 16 of the report, it states, "After I submitted my 17 preliminary report on November 16, 2018, I reviewed 18 additional documents provided by Johnson & Johnson and 19 Imerys through the course of this litigation as well as 20 documents produced after submitting my report." Is that 21 correct?</p> <p>22 A. Yes.</p> <p>23 Q. If you turn to pages 4 -- I'm sorry, page 24 5 of the report. You list the supplemental materials 25 and data considered?</p>	<p style="text-align: right;">Page 28</p> <p>1 A. I might have been confused with the Longo 2 title. It says, "Analysis of Johnson & Johnson's 3 historical product," so that might be the source of 4 the...</p> <p>5 Q. Do you know if there are anything else or 6 any other changes that you'd like to make to either the 7 supplemental or the original report?</p> <p>8 MS. SCOTT: Objection. Asked and 9 answered.</p> <p>10 BY MR. FROST:</p> <p>11 Q. You can answer.</p> <p>12 A. Do I --</p> <p>13 Q. Yeah. Do you know if there are any other 14 typos or anything else you'd want to correct in either 15 of the two reports?</p> <p>16 A. I think there are a few typos in the 17 report, or I'm, you know, I'm not perfect so...</p> <p>18 Q. We talked about, sort of, what's in the 19 binders over there and in the tubs. We'll start with 20 the binders, which are the documents. Did plaintiffs' 21 counsel provide all of the documents you relied on from 22 both Imerys and Johnson & Johnson in this case?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. I requested documents from the lawyers to 25 review.</p>
<p style="text-align: right;">Page 27</p> <p>1 A. Yes.</p> <p>2 Q. Am I also correct, you only list Imerys 3 documents as the additional materials reviewed?</p> <p>4 A. Yes.</p> <p>5 Q. Okay. So you, in fact, did not actually 6 review any additional Johnson & Johnson documents to 7 create this addendum; is that correct?</p> <p>8 MS. SCOTT: Objection.</p> <p>9 A. I don't remember specifically. That may 10 be a typo. I think I -- I think it's likely that I 11 looked at some Johnson & Johnson documents but only 12 ended up focusing on these others.</p> <p>13 BY MR. FROST:</p> <p>14 Q. Do you know what additional Johnson & 15 Johnson documents --</p> <p>16 A. I don't. I don't remember.</p> <p>17 Q. Okay. And I take it because they didn't 18 make it into the report, it's not something you're 19 relying on?</p> <p>20 MS. SCOTT: Objection.</p> <p>21 A. I don't know.</p> <p>22 BY MR. FROST:</p> <p>23 Q. Are there any other typos --</p> <p>24 A. So I think --</p> <p>25 Q. Go ahead.</p>	<p style="text-align: right;">Page 29</p> <p>1 BY MR. FROST:</p> <p>2 Q. What did you request from the lawyers?</p> <p>3 A. I requested any documents relating to the 4 mineralogy, the geology, things such as coring, x-ray 5 diffraction, bulk chemical tests, electron microscopy, 6 anything relating to, essentially, problems in 7 manufacturing or things that are related to how well 8 audits, for example -- audits would be a good example of 9 something that would be a third-party objective thing, 10 and I think there's, you know, there's an audit in here, 11 and any, any materials that would give sort of a big, 12 big picture of the situation at hand.</p> <p>13 Q. Did you ever ask to have access to all 14 the documents so you could perform searches yourself?</p> <p>15 A. I don't remember. I remember I reviewed 16 a lot of, a lot of documents, but I don't remember if I 17 specifically asked that. I asked for things relating to 18 what I just said.</p> <p>19 Q. Did you ever run any searches against any 20 documents to see if there's anything additional to what 21 was provided to you?</p> <p>22 MS. SCOTT: Object to form. You can 23 answer.</p> <p>24 A. What do you mean by "search"? So I 25 don't -- it was my understanding that -- so this is sort</p>

<p style="text-align: right;">Page 30</p> <p>1 of a closed system that, essentially, there's the</p> <p>2 documents that the company produces. If I were to</p> <p>3 search for something else, I don't necessarily know if</p> <p>4 that's from the company, right, or that's my thought.</p> <p>5 So I did not -- I didn't do any additional searches.</p> <p>6 BY MR. FROST:</p> <p>7 Q. So you just relied on the documents as</p> <p>8 provided to you by plaintiffs' counsel?</p> <p>9 A. Yes.</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. For these, for the documents that were</p> <p>12 used.</p> <p>13 BY MR. FROST:</p> <p>14 Q. And you have no way of knowing whether or</p> <p>15 not they've given you a complete set of every document,</p> <p>16 correct, that hits the categories you asked for?</p> <p>17 MS. SCOTT: Objection.</p> <p>18 A. I think it's very representative of a</p> <p>19 set. But, I mean, as I understand, there's, you know,</p> <p>20 an enormous amount of data, as there should be, and that</p> <p>21 is -- that would be expected, but, you know, I've</p> <p>22 reviewed what was requested.</p> <p>23 BY MR. FROST:</p> <p>24 Q. You reviewed what was provided, not what</p> <p>25 was requested, correct?</p>	<p style="text-align: right;">Page 32</p> <p>1 There's a lot of data, as I understand it. I don't</p> <p>2 think it's reasonable to review every document.</p> <p>3 Unfortunately, I'm one person, and if there's hundreds</p> <p>4 of thousands of pages of documents, yeah, I don't think</p> <p>5 any single person can review those in a reasonable</p> <p>6 manner.</p> <p>7 BY MR. FROST:</p> <p>8 Q. So you don't think it's important, as an</p> <p>9 expert giving opinions about the overall mining and</p> <p>10 sampling and testing practices of Johnson & Johnson, to</p> <p>11 have looked at or at least had access to the complete</p> <p>12 set of documents?</p> <p>13 MS. SCOTT: Objection.</p> <p>14 A. I think it's important to have a</p> <p>15 representative set, and that representative -- you know,</p> <p>16 so -- you know, I didn't look at one document. I didn't</p> <p>17 look at a few documents. You know, here's Hopkins'</p> <p>18 deposition, for example. There's all kinds of documents</p> <p>19 in that. There's a lot. There is a lot, but it's my</p> <p>20 expert opinion that the amount of documents that I</p> <p>21 reviewed were adequate to arrive at my conclusions.</p> <p>22 BY MR. FROST:</p> <p>23 Q. And, again, that's solely based on the</p> <p>24 set of documents that was compiled for you by</p> <p>25 plaintiffs' counsel in this case given to you, which you</p>
<p style="text-align: right;">Page 31</p> <p>1 A. What was provided that I requested from</p> <p>2 them.</p> <p>3 Q. And you don't know whether or not -- you</p> <p>4 have no way of telling, sitting here, whether or not</p> <p>5 you've been given the complete record, correct?</p> <p>6 MS. SCOTT: Objection. Asked and</p> <p>7 answered. You can answer if you can.</p> <p>8 A. I think it's, I think it's very</p> <p>9 representative. So I found examples where asbestos and</p> <p>10 contaminate -- essentially where asbestos was</p> <p>11 undetected. You know, I looked at a wide variety of</p> <p>12 things.</p> <p>13 BY MR. FROST:</p> <p>14 Q. But you would agree with me it's a</p> <p>15 representative set as chosen to be given to you by your</p> <p>16 counsel?</p> <p>17 MS. SCOTT: Objection.</p> <p>18 A. I think it's representative.</p> <p>19 BY MR. FROST:</p> <p>20 Q. You have no way of knowing what else</p> <p>21 might exist, correct?</p> <p>22 MS. SCOTT: Objection. Asked and</p> <p>23 answered. You can answer.</p> <p>24 A. So, yeah, there could be more bad reports</p> <p>25 out there. There could be more good reports out there.</p>	<p style="text-align: right;">Page 33</p> <p>1 don't know is complete or not, correct?</p> <p>2 MS. SCOTT: Objection.</p> <p>3 A. I believe it is a representative set of</p> <p>4 documents, but I did rely on what they provided as</p> <p>5 that's what I requested. I requested the documents, as</p> <p>6 I previously indicated in the answer.</p> <p>7 BY MR. FROST:</p> <p>8 Q. So you keep calling this a representative</p> <p>9 set, but how can you make a determination if a set is</p> <p>10 representative if you hadn't actually looked at or had</p> <p>11 access to the full set of documents?</p> <p>12 MS. SCOTT: Objection.</p> <p>13 A. It's my expert opinion that's a -- it's a</p> <p>14 reasonable amount of documents. There's, you know --</p> <p>15 BY MR. FROST:</p> <p>16 Q. So you're basing the representativeness</p> <p>17 off of the sheer size of the pile of documents on the</p> <p>18 table?</p> <p>19 MS. SCOTT: Objection.</p> <p>20 A. It's what I think is a representative</p> <p>21 population of documents. I mean, there's -- there are a</p> <p>22 lot of documents, but I've -- and I've looked at a lot</p> <p>23 of documents, and I've arrived at my professional</p> <p>24 opinion based on the review of those documents.</p> <p>25</p>

<p style="text-align: right;">Page 34</p> <p>1 BY MR. FROST:</p> <p>2 Q. Would it change your opinion --</p> <p>3 A. I can't ask a question, right?</p> <p>4 Q. No.</p> <p>5 A. Okay. All right. Yeah.</p> <p>6 Q. Would it change your opinion if you knew</p> <p>7 that the set of documents provided to you by plaintiffs'</p> <p>8 counsel only represents a portion of the story and there</p> <p>9 are hundreds and possibly thousands of additional</p> <p>10 documents that weren't provided to you by counsel?</p> <p>11 MS. SCOTT: Objection.</p> <p>12 A. So those documents would not negate the</p> <p>13 findings of the report. So, for example, if there was</p> <p>14 an additional document that said talc was undetected, it</p> <p>15 wouldn't negate the findings of the materials starting</p> <p>16 on page 14.</p> <p>17 BY MR. FROST:</p> <p>18 Q. Well, that's -- I'm glad you brought that</p> <p>19 up, because we'll get to those at the end of the</p> <p>20 deposition, because I think you were actually not</p> <p>21 provided some very important documents regarding that</p> <p>22 chart, but we'll turn back to that later when we start</p> <p>23 going through the report.</p> <p>24 A. Okay.</p> <p>25 Q. But it wouldn't change your opinion at</p>	<p style="text-align: right;">Page 36</p> <p>1 on page 5 of the shorter document.</p> <p>2 Q. Okay. And these are all Longo expert</p> <p>3 reports, correct, Longo testing reports?</p> <p>4 A. Yes.</p> <p>5 Q. Did you ever see any draft reports from</p> <p>6 any other experts in these cases before you finished</p> <p>7 yours?</p> <p>8 A. No, I did not.</p> <p>9 Q. Have you reviewed any other expert</p> <p>10 reports given in any talcum powder cases other than this</p> <p>11 one? You know, for example, were you provided any</p> <p>12 expert reports from other cases against Johnson &</p> <p>13 Johnson?</p> <p>14 A. I'm trying to think about the other case</p> <p>15 for a moment. I don't remember.</p> <p>16 Q. And have you reviewed any deposition or</p> <p>17 trial transcripts in either preparation of your report</p> <p>18 or to prepare for today's deposition?</p> <p>19 A. Yes.</p> <p>20 Q. What depositions have you reviewed?</p> <p>21 A. Hopkins.</p> <p>22 Q. I guess I'll ask it a different way.</p> <p>23 Other than the ones that are already reflected in your</p> <p>24 report, have you reviewed any depositions of any other</p> <p>25 experts in talcum powder cases, any other, you know,</p>
<p style="text-align: right;">Page 35</p> <p>1 all to know that you were only given a selection of</p> <p>2 documents that supported plaintiffs' theories in this</p> <p>3 case?</p> <p>4 MS. SCOTT: Objection. Asked and</p> <p>5 answered.</p> <p>6 A. No. My opinion remains unchanged.</p> <p>7 BY MR. FROST:</p> <p>8 Q. And, again, it wouldn't change your</p> <p>9 opinion if you knew that there are documents that</p> <p>10 specifically refute some of the findings that you've</p> <p>11 relied on in these reports?</p> <p>12 MS. SCOTT: Objection.</p> <p>13 A. Again, my opinion remains unchanged. The</p> <p>14 data present demonstrates that there was asbestos</p> <p>15 materials and metals materials.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Have you reviewed any reports from other</p> <p>18 experts in this case?</p> <p>19 A. Yes.</p> <p>20 Q. We know you reviewed Longo. You</p> <p>21 mentioned that in the report. Anybody else other than</p> <p>22 Dr. Longo?</p> <p>23 A. Not -- let me look here. So the expert</p> <p>24 reports are listed on page 97, and there are four of</p> <p>25 those. And then the expert report, there's one listed</p>	<p style="text-align: right;">Page 37</p> <p>1 other than --</p> <p>2 A. Not that I remember.</p> <p>3 Q. -- Dr. Downey, Dr. Hopkins?</p> <p>4 A. I don't remember.</p> <p>5 THE WITNESS: Can we take a little break?</p> <p>6 MR. FROST: Sure.</p> <p>7 VIDEOGRAPHER: We're now going off</p> <p>8 record. The time is 9:53.</p> <p>9 (A recess was taken from 9:53 to 10:04.)</p> <p>10 VIDEOGRAPHER: We are now back on record</p> <p>11 and the time is 10:04.</p> <p>12 BY MR. FROST:</p> <p>13 Q. All right. Before going on the break, we</p> <p>14 talked about whether or not you'd read any depositions</p> <p>15 of any other experts in these cases. Has plaintiffs'</p> <p>16 counsel ever discussed with you the testimony of any</p> <p>17 other experts in these cases?</p> <p>18 MS. SCOTT: Objection.</p> <p>19 MS. O'DELL: I would instruct the</p> <p>20 witness -- I'm sorry. Instruct the witness not</p> <p>21 to discuss anything that's been discussed or</p> <p>22 communicated with plaintiffs' counsel.</p> <p>23 MR. FROST: Let's mark the record. I</p> <p>24 disagree with that assumption because, you know,</p> <p>25 I believe any discussion of depositions in these</p>

<p style="text-align: right;">Page 38</p> <p>1 cases is discoverable under the federal rules, 2 but I'll move on. All right. 3 BY MR. FROST: 4 Q. Was there anything you asked plaintiffs' 5 counsel to provide for you in this case to help prepare 6 your reports that you were not given? 7 A. I'm sorry. Can you just say that again? 8 Q. Sure. Was there anything you asked 9 plaintiffs' counsel to provide you in preparation of 10 your report that you were not given or you didn't 11 receive? 12 A. No. I believe they gave me 13 representative materials of what I requested. I'm not 14 sure, but I also have the materials that I rely on. So 15 like the, you know, reviews in mineralogy books and 16 things like that are in the reliance list, but I 17 acquired those. They did not produce those. 18 Q. Okay. That was actually my next question 19 is that the stuff that's under your reliance material 20 list, is that things that you independently found 21 yourself or that were provided to you by counsel? 22 A. Yeah, yeah. Those are things I found. 23 Q. Were any of the articles -- 24 A. Those -- 25 Q. I'm sorry?</p>	<p style="text-align: right;">Page 40</p> <p>1 reports or were they just provided to you and then you 2 included them in your final opinion paper? 3 A. The chart? 4 MS. SCOTT: Objection. 5 BY MR. FROST: 6 Q. That was a bad question. Did you do any 7 editing of the charts that were included in the final 8 report or did you just put them in as provided by 9 counsel? 10 A. I directed them to put them in. 11 Q. So plaintiffs' counsel ultimately put it 12 into the report the way it's structured? 13 MS. SCOTT: Objection. 14 A. I indicated the documents to be included 15 in the table, and they put it in the table. 16 BY MR. FROST: 17 Q. Is that true for all of the tables or did 18 they produce -- did they provide some of the content of 19 the tables as well? 20 MS. SCOTT: Objection. 21 A. I'd have to look to refresh. 22 BY MR. FROST: 23 Q. That's okay. Take your time. 24 A. I'm already a little tired. That table, 25 I requested them to do. And that table. Sorry. I'm</p>
<p style="text-align: right;">Page 39</p> <p>1 A. Those are things I found on my own. You 2 know, many of the books I -- some I just had on my 3 shelf, you know. I've actually gone through three 4 versions of some of them. 5 Q. So were any of the reports, treatises, 6 books, et cetera, you relied on provided to you by 7 plaintiffs' counsel? 8 A. No, I don't think so. 9 Q. Did anybody help you prepare the report? 10 A. I asked counsel to create the charts that 11 are in the report, and this was my first time doing such 12 an extensive report. So I asked about organizational 13 issues, things like that. 14 Q. What about other than the charts that 15 appear in the report? Did counsel assist you with any 16 of the other -- the word just escaped my mind. I 17 apologize. 18 A. Text? 19 Q. Any of the other, sort of principle of 20 research or any of the other opinions that are in the 21 paper? 22 MS. SCOTT: Objection. 23 A. No. 24 BY MR. FROST: 25 Q. And did you have any hand at editing the</p>	<p style="text-align: right;">Page 41</p> <p>1 new at this, a little bit nervous. So I directed them 2 to put those tables in. 3 Q. Okay. Did you direct them to -- I'll 4 strike that. 5 So the actual documents that are 6 reflected in the tables, was that your work that you -- 7 A. Those are documents I reviewed, yes. 8 Q. Okay. And you're the one who put 9 together the list of documents for them ultimately to 10 put in table form to include in the report? 11 MS. SCOTT: Objection. Asked and 12 answered. 13 A. Ultimately, I selected the documents, 14 told them to put them in. 15 BY MR. FROST: 16 Q. In forming your opinions to this report, 17 did you have to come to any -- did you have to make any 18 assumptions that you relied on, then, for your ultimate 19 opinions? 20 MS. SCOTT: Objection. 21 A. That's kind of a tricky question. I 22 assumed that the documents provided by the company were 23 genuine. 24 BY MR. FROST: 25 Q. Okay. Any other assumptions you had to</p>

<p style="text-align: right;">Page 42</p> <p>1 make to reach your opinions?</p> <p>2 A. I'm just thinking. I -- I don't think</p> <p>3 so. I -- I assume that documents that I reviewed were</p> <p>4 genuine, I guess, is maybe the best way to express that.</p> <p>5 Q. And by "genuine," do you mean, you know,</p> <p>6 part of the actual documents accompanied?</p> <p>7 A. They weren't altered in some way or --</p> <p>8 Q. Okay. Yep.</p> <p>9 A. Sometimes it was, you know, there were --</p> <p>10 so, for example, the SEM document in this report and,</p> <p>11 actually, other things, the images were extremely</p> <p>12 degraded. It appeared that several documents had been</p> <p>13 photocopied, so one could supplant things. You know,</p> <p>14 again, I don't know, so that's why I say that I assume</p> <p>15 things are genuine.</p> <p>16 Q. Okay. I think we're on the same page</p> <p>17 about what "genuine" means. I just wanted to make sure.</p> <p>18 A. Yeah.</p> <p>19 Q. All right. And do you agree with me that</p> <p>20 in forming your opinions, it's important for you to keep</p> <p>21 a fair and open mind and look at the data in an</p> <p>22 impartial way?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. I believe it's important to look at data,</p> <p>25 yes.</p>	<p style="text-align: right;">Page 44</p> <p>1 role was to be objective. And I reviewed several</p> <p>2 documents, you know, numerous, numerous, numerous</p> <p>3 documents objectively.</p> <p>4 BY MR. FROST:</p> <p>5 Q. And did you know what role the counsel</p> <p>6 who engaged you had? Did you know that you were</p> <p>7 representing the plaintiffs versus the company?</p> <p>8 A. I'm sorry. I missed a word.</p> <p>9 Q. Did you know what role you were hired to</p> <p>10 do?</p> <p>11 A. I knew they were on the side of the</p> <p>12 plaintiffs, yes.</p> <p>13 Q. And you knew that, ultimately, they were</p> <p>14 looking for evidence of bad mining practices and</p> <p>15 opinions regarding inadequate sampling, things of that</p> <p>16 nature?</p> <p>17 MS. SCOTT: Objection.</p> <p>18 A. I think they -- it's my opinion that they</p> <p>19 were looking for data to support their case in some way</p> <p>20 and also evaluate, potentially, if there was not a case.</p> <p>21 BY MR. FROST:</p> <p>22 Q. Do you believe there's any additional</p> <p>23 data you need to see in order to fully evaluate the</p> <p>24 mining practices and the sampling practices by the two</p> <p>25 companies in this case?</p>
<p style="text-align: right;">Page 43</p> <p>1 BY MR. FROST:</p> <p>2 Q. Do you believe it's important to look at</p> <p>3 it in an impartial way?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. I did look at things impartially, yes.</p> <p>6 BY MR. FROST:</p> <p>7 Q. Coming in to your review of the</p> <p>8 documents, were you told what plaintiffs' liability</p> <p>9 theories were in this case?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. I don't know what that word means.</p> <p>12 BY MR. FROST:</p> <p>13 Q. Sure.</p> <p>14 A. What's plaintiff liability theory?</p> <p>15 Q. Yeah. I'll ask it a different way.</p> <p>16 A. Okay.</p> <p>17 Q. Before you were coming in to review the</p> <p>18 documents, were you told by plaintiffs, ultimately, what</p> <p>19 an opinion or what type of opinion they were looking</p> <p>20 for?</p> <p>21 MS. SCOTT: Objection.</p> <p>22 A. No, not really. I mean, in our early</p> <p>23 discussions, my job was to evaluate the data, so -- and</p> <p>24 I feel I've done that objectively. I knew it was</p> <p>25 connected to a case involving ovarian cancer, but my</p>	<p style="text-align: right;">Page 45</p> <p>1 MS. SCOTT: Objection. Asked and</p> <p>2 answered multiple times.</p> <p>3 A. I would consider looking at other data,</p> <p>4 of course, but looking at that other data would not</p> <p>5 change the opinions expressed in this report. Other</p> <p>6 data doesn't negate the fact that we have all these</p> <p>7 occurrences of materials. I mean, so there's over 90</p> <p>8 occurrences documented or there's about 90 or so in the</p> <p>9 one table of asbestos. You know, it doesn't negate --</p> <p>10 for me, fundamentally, it's using the powder x-ray</p> <p>11 diffraction as the screening method that's fundamentally</p> <p>12 flawed. The reasons, you know, I don't want to -- do</p> <p>13 you want me to --</p> <p>14 BY MR. FROST:</p> <p>15 Q. We'll get to that.</p> <p>16 A. I can stop.</p> <p>17 Q. We'll turn to that later.</p> <p>18 A. Okay. All right. Good.</p> <p>19 Q. You said before you're not a medical</p> <p>20 doctor, right?</p> <p>21 A. I'm sorry? Medical doctor, no.</p> <p>22 Q. And you're not a toxicologist, right?</p> <p>23 A. Correct.</p> <p>24 Q. And do you consider yourself a regulatory</p> <p>25 expert?</p>

<p style="text-align: right;">Page 46</p> <p>1 A. No.</p> <p>2 Q. And you're not an expert in regulatory</p> <p>3 processes or mine regulations?</p> <p>4 A. No, I'm not an expert.</p> <p>5 Q. Before working on this report, have you</p> <p>6 ever worked with talc before?</p> <p>7 A. In my class work, my advisor was Steve</p> <p>8 Guggenheim, and, of course, Warren Huff was my master's</p> <p>9 advisor. So I had several clay mineralogy classes, and</p> <p>10 we analyzed talc. And my Ph.D. advisor specifically,</p> <p>11 you know, he would tell me, go look at this mineral with</p> <p>12 the TEM and x-ray, so I would know and be familiar with</p> <p>13 things, so but I don't have a specific thing on talc.</p> <p>14 Q. So other than, you know, your use of it</p> <p>15 in undergraduate and graduate and Ph.D. work, you know,</p> <p>16 you've never studied talc, you've never published on</p> <p>17 talc, anything like that?</p> <p>18 A. No.</p> <p>19 Q. Other than, you know, looking at it so</p> <p>20 you'd be able to identify minerals, have you ever done</p> <p>21 any examination or testing of talc?</p> <p>22 A. Other than just looking at it for -- as</p> <p>23 far as learning the details of the mineral, no.</p> <p>24 Q. Have you ever been to a talc mine?</p> <p>25 A. Yes, in California. There's this mine in</p>	<p style="text-align: right;">Page 48</p> <p>1 for the record, you don't know one way or the other</p> <p>2 whether this mine --</p> <p>3 A. I don't know the exact source.</p> <p>4 MS. SCOTT: Be careful you don't talk</p> <p>5 over one another.</p> <p>6 THE WITNESS: I'm sorry.</p> <p>7 MS. SCOTT: That's okay.</p> <p>8 THE WITNESS: I apologize.</p> <p>9 BY MR. FROST:</p> <p>10 Q. And when you were at this mine in Darwin,</p> <p>11 I take it there were no mine operations continuing at</p> <p>12 the time you were visiting?</p> <p>13 A. I believe it would just be alum land.</p> <p>14 But dealings and things were -- you know, I mean, things</p> <p>15 were there.</p> <p>16 Q. And you can't tell me what type of talc</p> <p>17 that was produced, whether it was industrial talc,</p> <p>18 cosmetic talc or something else, right?</p> <p>19 A. Correct. I don't know. There's no</p> <p>20 record. We found it in a guidebook, thought it'd be a</p> <p>21 good experience for the students.</p> <p>22 Q. And other than that visit, you've</p> <p>23 certainly never been to a talc mine that is currently</p> <p>24 undergoing operation, correct?</p> <p>25 A. Correct.</p>
<p style="text-align: right;">Page 47</p> <p>1 Darwin. So Darwin was this area in California on the</p> <p>2 south side of Joshua Tree, and there's asbestos all over</p> <p>3 the place, and the mine closed -- if I remember</p> <p>4 correctly, the mine closed, like, in the '50s. So it</p> <p>5 might have been, you know, the mine that was -- where</p> <p>6 things were sourced from when the Italian mines were not</p> <p>7 around or, you know, the World War II era.</p> <p>8 But, yeah, I went there with Brian</p> <p>9 Currie, and we do a field trip to Death Valley and the</p> <p>10 surrounding areas all the time. So, yes, I've been to</p> <p>11 at least that talc mine, and I've been on several --</p> <p>12 I've been on field trips to, like, metamorphic terrains</p> <p>13 in New England states, but I can't remember if I saw</p> <p>14 talc there or not. I have not physically been to the</p> <p>15 Vermont mines, but, yes, I've been to a talc mine.</p> <p>16 Q. So you just made the statement that this</p> <p>17 mine in Darwin, you know, may have been during World War</p> <p>18 II, where they -- I'm looking at the thing -- where they</p> <p>19 source talc from. That's just a guess by you, correct?</p> <p>20 A. Correct. As I said, it may have been.</p> <p>21 But the region, as I understand thinking about that</p> <p>22 field trip, you know, I may be foggy, but there's other</p> <p>23 talc mines in the area. But, yeah, there was asbestos</p> <p>24 in that.</p> <p>25 Q. Okay. But, again, I just want to clarify</p>	<p style="text-align: right;">Page 49</p> <p>1 Q. Have you ever published anything</p> <p>2 regarding amphiboles?</p> <p>3 A. I'm trying to think. My master's thesis</p> <p>4 had -- there were amphiboles in those bentonites. Aside</p> <p>5 from that, I don't think so, or if I did, it was not a</p> <p>6 major component. Not memorable.</p> <p>7 Q. And other than what you recall in your</p> <p>8 thesis, you've never done any testing of amphiboles or</p> <p>9 anything of that nature?</p> <p>10 A. I'm trying to -- well, I have nothing</p> <p>11 published, but I have ran across -- so I've done -- you</p> <p>12 know, I have several. I have many projects with</p> <p>13 students, and some of those projects, for example, I</p> <p>14 think I -- there were minerals that I would identify in</p> <p>15 the TEM as amphibole for the coke formation, which was</p> <p>16 kind of unusual. So the coke formation is a local</p> <p>17 bedrock.</p> <p>18 Q. Okay.</p> <p>19 A. So but nothing -- nothing in the</p> <p>20 peer-review literature, and I don't even know if it was</p> <p>21 mentioned in the abstract. I do remember occasionally</p> <p>22 running across amphiboles. It's amazing what you'll</p> <p>23 find in the TEM. There's all kind of crazy stuff if you</p> <p>24 look for it. Yeah.</p> <p>25 Q. And I think we covered this before, but</p>

<p style="text-align: right;">Page 50</p> <p>1 you've never done any testing of talcum powder or 2 over-the-counter cosmetic products, right? 3 A. No. 4 Q. Before you were contacted by plaintiffs' 5 attorneys in -- it sounds like about December, give or 6 take, of 2017, had you ever done any research regarding 7 talc, talcum powder, anything of that nature? 8 A. No. 9 Q. And had you ever done any research prior 10 to being contacted about the mining practices at talc 11 mines or looking at the geological mine deposits? 12 A. I'm sorry. A research on, on talc 13 mining? 14 Q. Exactly. Talc-mining practices. 15 A. Specifically? No. 16 Q. Okay. Well, what about the geology of 17 the specific -- you know, did you ever look at the 18 specific geology of any talc mines prior to being 19 engaged in this case? 20 A. I took a metamorphic course, and during 21 my master's, under Craig Dietsch, I remember we talked 22 about talc in that class. So Craig is a metamorphic 23 petrologist. So -- and then, you know, my -- I've read 24 papers. I mean, all through my Ph.D., my advisor 25 hammered that I should read everything around the topic.</p>	<p style="text-align: right;">Page 52</p> <p>1 Q. And you certainly have never written any 2 opinions regarding talc, talc mining practices, you 3 know, et cetera, before getting engaged in this case and 4 the other case from Waters & Kraus, right? 5 A. Correct. 6 MS. SCOTT: Objection. 7 BY MR. FROST: 8 Q. On your CV, I know you notice you have a 9 patent for something called asbestos containment 10 composition. 11 A. Yes. 12 Q. What is that? 13 A. It's a mixture of clay minerals. 14 Q. And what's the patent? 15 A. Basically, it's a mixture of kaolinite 16 and montmorillonite, if I recall. Essentially, it's one 17 we produced but didn't really pursue. It was actually 18 my brother-in-law thought it would be a good idea. So 19 but, yeah. 20 Q. So it's patented but not in production or 21 use? 22 A. Right. And I don't regard patents as 23 peer-review literature. Those are -- that's a 24 different. 25 Q. Yeah. I actually agree with you on that</p>
<p style="text-align: right;">Page 51</p> <p>1 So -- but I've not -- I haven't mapped a talc deposit, 2 for example. 3 Q. So I guess the best way to put it, and 4 you can correct me if I'm wrong, but it sounds like 5 you've read papers about talc deposits and all other 6 types of deposits. 7 A. That's in my training. 8 Q. But you never did any specific research 9 narrowing down on talc deposits, specifically? 10 A. Correct. I have no peer-review 11 literature on talc. 12 Q. Have you ever attended any conferences 13 that talk about talc mining or specific, you know, talc 14 mine geology? 15 A. I've attended several clay minerals 16 society meetings periodically throughout my career. I 17 haven't attended any in a few years. I don't remember 18 their names, but, you know, I remember seeing some stuff 19 on talc, nothing specific. I was always focused on 20 either the bentonites or palygorskite/sepiolite. 21 Q. Okay. So there might -- you know, these 22 various conferences, talc might have been a topic, but 23 it wasn't something you were there to concentrate on or 24 to talk about? 25 A. Correct.</p>	<p style="text-align: right;">Page 53</p> <p>1 one. 2 A. Yeah. 3 Q. I was just -- I couldn't find the 4 patents, so I was wondering what it was. 5 A. Oh, surprise. 6 Q. All right. If you want to open your 7 report to page -- it's Exhibit 1 in front of you. 8 A. Okay. 9 Q. To page 45. Do you have a summary of the 10 opinions you're rendering in this case? 11 A. Okay. 12 Q. And in looking at one through five there, 13 are those the five opinions that you believe are 14 supported by the report? 15 MS. SCOTT: Objection. 16 A. Yeah, I believe these are, these are my 17 opinions. That's the -- essentially, these are the 18 summary of those opinions. 19 BY MR. FROST: 20 Q. Okay. And these fairly reflect the 21 opinions you intend to offer in this case? There's 22 nothing else that you can think of that you're going to 23 opine about? 24 A. With respect to this report, correct. 25 Q. And then I note in the addendum report,</p>

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<p>1 there's not an additional opinion given. I think the 2 report states that it supports the opinions given in the 3 preliminary report; is that correct? 4 A. Let me look. 5 Q. That's Exhibit 2. I believe the quote is 6 that "it supports and further enhances my opinions 7 outlined in the original report"? 8 A. Correct, yeah. 9 Q. So you agree with me there are no new 10 opinions in the addendum report. It's just additional 11 support for the five opinions you plan to render in this 12 case? 13 A. There's no new opinions. The silver -- 14 there's new data, but, yeah, there's no new opinions. 15 It's the addendum supports the first. 16 Q. And I take it you haven't published this 17 report or published these opinions anywhere, have you? 18 A. Absolutely not. 19 Q. Do you intend to publish them? 20 A. No. 21 Q. Do you intend to publish any of the 22 research you've done with relation to this report? 23 A. No. 24 Q. Did anybody help you do any of the, the 25 research underlying the report?</p>	<p>1 but I had read those during my dissertation time as 2 well. 3 Q. Did you go -- 4 A. So I was -- I'm sorry. 5 Q. I'm sorry. I didn't mean to cut you off. 6 I thought you were done. 7 A. So I'm familiar with a broad range of 8 literature. 9 Q. Did you have to go out and do any 10 searches for new literature that you didn't already have 11 in your possession? 12 A. We got some materials from -- or I got 13 some materials from the library, and there were some 14 things like Gy were things I knew of and Finkelstein 15 were things I knew of that had been discussed either in 16 my classes or I ran across it previously that I had to 17 go re-get. 18 Q. Did you spend any time doing any, what 19 I'll call sort of new or independent research in 20 addition to things you've already done in the past to 21 prepare your report? 22 A. I don't understand the question. In the 23 sense that? 24 Q. For example, did you spend any time in a 25 research library trying to find all the articles about</p>
Page 55	Page 57
<p>1 A. No. 2 Q. So all the opinions and all the analysis 3 in the original report and the addendum report, you 4 know, are all things that you've researched yourself and 5 are solely your opinion and your -- 6 A. Yep. 7 Q. -- based on your work. Okay. 8 So you have, I believe it's a couple 9 boxes, right, of stuff on the ground that are articles 10 and textbooks? How did you actually go about selecting 11 the literature you were going to review in this case? 12 A. The stuff outside? 13 Q. Yes, the stuff outside the documents. 14 A. So I was informed by, you know, really, 15 the core of my Ph.D. So I had a class on crystal 16 chemistry and phyllosilicates, and basically, I was 17 expected to read and learn things. And so my collection 18 of books is, in part, from that effort. And then, also, 19 I teach classes regularly, so I'm familiar with the 20 books that I use in those classes and then, also, citing 21 things for research. 22 So I had a master's student who did a 23 thesis on New Caledonia, which has talc and asbestos and 24 other things. So, essentially, you know, the Brinley 25 papers were an example of, you know, those came back up,</p>	<p>1 the different geological deposits at issue in this case? 2 A. No. My opinion, the knowledge set I had 3 generated over decades was appropriate reference point. 4 So I didn't, I didn't look at, you know, French 5 literature, Chinese or Russian literature, for example. 6 Q. Do you agree with me that the standard 7 for rendering your opinions in peer-reviewed literature 8 is different than the standard for rendering opinions in 9 litigation cases? 10 MS. SCOTT: Objection. 11 A. That's a -- sort of a complex question. 12 Can I talk about? 13 BY MS. SCOTT: 14 Q. Sure. 15 A. So industrial mineral companies, margins 16 are not great. So, basically, the profits are not 17 great. So, you know, there's not -- well, I should back 18 up. Industrial mineral companies, other mineral 19 companies, they rely on peer-review literature for their 20 analytical standards and practices. So, essentially, 21 peer-review literature is kind of part of that. They 22 don't -- mineral companies don't necessarily talk to 23 each other. There are, like, societies, so there's a 24 clay mineral society. I think there's a zeolite 25 society. But the sort of industrial secrets or the</p>

<p style="text-align: right;">Page 58</p> <p>1 details and methods, you know, everyone's afraid that 2 they're going to get ripped off from someone else. So 3 peer-review literature is a sort of common ground that 4 everyone uses. 5 Q. I guess I'll ask the question a different 6 way. 7 A. Okay. 8 Q. Because it was about, sort of, the 9 standard for opinions. Do you believe that the standard 10 of review for an opinion, you know, such as in the 11 expert report you've given in this case, is the same or 12 different than the standard review if you were trying to 13 publish a peer-reviewed article on the same subject? 14 MS. SCOTT: I'm going to object and ask 15 him not to speculate on your initial question in 16 any legal standards. 17 A. Yeah. I am -- as I -- I'm not familiar 18 with legal review. 19 BY MS. SCOTT: 20 Q. Do you believe the -- when you were 21 writing the report, do you believe that the opinions in 22 this report, you know, would meet or be sufficient for 23 peer-review publication? 24 MS. SCOTT: Objection. 25 A. I don't want -- I'm not an editor. I</p>	<p style="text-align: right;">Page 60</p> <p>1 regarded that metamorphic rock, metamorphic terrains 2 take a long time to form. So pressure temperature 3 loops, and this is well documented in the geologic 4 literature. You know, it's in the classwork that I've 5 had. 6 Q. Would you agree with me that some talc 7 deposits form -- you know, the formation of talc 8 deposits, some take a lot longer, some take a lot 9 shorter, depending upon the characteristics of the 10 formation? 11 MS. SCOTT: Objection. 12 A. I'm not gonna speculate without data. 13 But, you know, generally it's accepted that talc 14 deposits take several millions of years to form. 15 BY MR. FROST: 16 Q. What's your basis of that opinion? 17 A. My classwork. 18 Q. Can you tell me what factors affect the 19 formation of talc, what the controlling factors of 20 metamorphism would be? 21 A. Heat and pressure and fluids. 22 Q. Would you agree with me that not all talc 23 is formed with the exact same amount of heat, pressure 24 and fluids in the mix? 25 A. There is variability.</p>
<p style="text-align: right;">Page 59</p> <p>1 don't want to speculate. 2 BY MS. SCOTT: 3 Q. That's fine. Turning in to your report. 4 Start at page 2. So you state that "Talc is a mineral 5 derived almost exclusively from metamorphic deposits," 6 right? 7 A. Correct. 8 Q. You also agree with me that not all talc 9 forms through a metamorphic process, right? 10 A. You can have soils developed on talc 11 deposits, so, yes. 12 Q. Yes, you can have talc form -- 13 A. Developed on. And then you can also have 14 potential hydrothermal alteration at mid-ocean ridges, 15 which is also a metamorphic. It's hydrothermal 16 alteration. 17 Q. You also state further down that the 18 process of metamorphism occurs over several tens of 19 millions of years. Is that always the case? 20 A. Generally, that's the case, you know, in 21 rocks where you have talc occurring, yes. 22 Q. Do you think that's true for all talc 23 deposits that have formed? 24 A. For, you know, the instances of mid-ocean 25 ridge, perhaps not, but, essentially, it's generally</p>	<p style="text-align: right;">Page 61</p> <p>1 Q. Would you agree with me that not all talc 2 deposits are geologically the same? 3 MS. SCOTT: Objection. 4 A. I don't think any -- every rock and every 5 geologic deposit has its own history, so one of the big 6 things that's come out in mineralogy is mineralogical 7 evolution. And Bob Hazen's paper talks about this, and 8 there's been several successive papers. So based on 9 that, you know, every deposit has individual 10 characteristics, but there's general sort of groups or 11 classes. 12 BY MR. FROST: 13 Q. And you'd agree with me that not every 14 mined deposit of talc is the same either, correct? 15 A. It all depends on what you mean by "the 16 same." You know, you can have things that are not the 17 same but very similar. 18 Q. Sure. But not every mined deposit is 19 going to be exactly the same chemically, geologically. 20 They're all going to form in different ways at different 21 times. Would you agree with that? 22 A. Unless they are geologically related. So 23 you can have two parts. You can have multiple deposits 24 in the same geologic terrain that form at approximately 25 the same time. Other issues, I mean there's issues with</p>

<p style="text-align: right;">Page 62</p> <p>1 geochronology, right? So, you know, age range errors 2 can be plus or minus 10 million years. So if you have a 3 age of a metamorphic deposit that is talc and the age is 4 plus or minus 20 million years, you know, based on the 5 available data, that's a reasonable, you know, 6 chronometric value. 7 Q. Sure. And based upon when it formed, how 8 it formed, the pressures, the temperatures, whether or 9 not there's variability of that would effect what other 10 minerals might be with the talc, right? 11 A. Correct. 12 Q. And also depending what surrounding rock 13 there is to the rock that changed to talc would also, 14 you know, affect what might be on the margins of a talc 15 deposit, for example? 16 A. I'm sorry. The last part of your 17 question? 18 Q. Sure. So depending what the surrounding 19 rock was to the rock that metamorphosed to talc would 20 also affect what you would see in the black wall, for 21 example, what you see at the boundaries for the talc, 22 right? 23 A. It can, if there's a reaction or not, so 24 it's dependent upon the situation. 25 Q. That's what I was going to stay. It's</p>	<p style="text-align: right;">Page 64</p> <p>1 A. Yes, it does. 2 Q. And that's effectively what we're talking 3 about here, is that it's the other minerals that were 4 around during the formation of the talc. They may be in 5 the deposit, they may not, and they may be different 6 depending on deposits, right? 7 MS. SCOTT: Objection. 8 A. I'm sorry. Can you -- 9 BY MS. SCOTT: 10 Q. Sure. So you agree with me that not 11 every talc deposit is going to have the same exact 12 associated other minerals with talc, right? 13 MS. SCOTT: Objection. 14 A. It depends, because, I mean, you have -- 15 so, in mineralogy, we have a term called "perigenesis." 16 So essentially, there are -- these common minerals are 17 associated with each other. So out of context, for 18 example, galena and sphalerite are very commonly 19 associated with each other. 20 So, essentially, I think a more correct 21 way of saying things is that chrysotile asbestos and 22 talc are commonly associated with each other. So 23 perhaps not all talc deposits have the same mineral 24 assemblage, but many of them do have very similar 25 mineral assemblages, and that's even when the chemistry</p>
<p style="text-align: right;">Page 63</p> <p>1 variable, and it changes from deposit to deposit? You 2 have to look specifically? 3 A. That's why every deposit should be 4 evaluated with an appropriate core density and high 5 sampling density. 6 Q. So in order to fully understand what's in 7 a particular talc deposit, you really do need to know 8 how it formed, what was with it when it formed, what's 9 around it, things like that, right? 10 A. I'm sorry. To understand a talc deposit? 11 Q. Yes. 12 A. At what level or what understanding, what 13 context? 14 Q. To understand what specifically, you 15 know, is associated with that talc, what other minerals 16 might be associated with the talc, you really have to 17 look at the specific deposit, how it was formed, what 18 other constituent minerals were around it, things of 19 that nature, correct? 20 A. Yes. One should evaluate what is in the 21 deposit and what is adjacent to the deposit. 22 Q. You also state on page 2, on the next 23 paragraph down, that "Talc can have, and commonly does 24 have, natural impurities." And that's effectively what 25 we're talking about?</p>	<p style="text-align: right;">Page 65</p> <p>1 varies. 2 BY MS. SCOTT: 3 Q. And that's what I'm getting to, is just 4 because some minerals are associated with talc doesn't 5 mean that other mineral is going to be in every single 6 talc deposit in the world, right? 7 MS. SCOTT: Objection. 8 A. Correct, but that doesn't mean that's not 9 very common, either. 10 BY MR. FROST: 11 Q. Sure. But we're talking about -- you 12 agree with my statement that not every single talc 13 deposit in the world will have all of the same exact 14 accessory minerals associated with it, right? 15 MS. SCOTT: Objection. Calls for 16 speculation. 17 A. Yeah. I don't want to speculate on that. 18 BY MR. FROST: 19 Q. It's not speculation. 20 A. Because, you know, there's -- 21 Q. Isn't it science? 22 A. You know, I go back to the New Caledonia 23 example. It has talc, but not every talc deposit has 24 New Caledonia assemblages. 25 Q. Okay. So the answer to my question would</p>

<p style="text-align: right;">Page 66</p> <p>1 be yes, right, that not every single talc deposit has</p> <p>2 the exact same accessory minerals associated with it?</p> <p>3 MS. SCOTT: Objection.</p> <p>4 A. Correct.</p> <p>5 BY MR. FROST:</p> <p>6 Q. And you also agree with me that -- I'm</p> <p>7 going to use the word, you know, "pure," to mean more</p> <p>8 talc, but there are some talc deposits that are more</p> <p>9 pure than other talc deposits. There's some talc</p> <p>10 deposits that are comprised of more talc than others,</p> <p>11 correct?</p> <p>12 MS. SCOTT: Objection.</p> <p>13 A. It's -- so it's speculative. I don't</p> <p>14 know exactly what you mean by "pure." So it's been</p> <p>15 known, for example, that at the atomic level, you can</p> <p>16 have intergrowths with chrysotile with talc. So, yeah.</p> <p>17 I'm really not quite sure how to answer that question.</p> <p>18 BY MR. FROST:</p> <p>19 Q. So you have no opinion that if I were to</p> <p>20 go find a talc deposit over here and find one over here,</p> <p>21 that one might have -- be comprised of more talc or have</p> <p>22 a more pure metamorphism of the talc than another?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. Without any priority knowledge -- yeah.</p> <p>25 I would want to -- to answer that question correctly,</p>	<p style="text-align: right;">Page 68</p> <p>1 chrysotile.</p> <p>2 BY MR. FROST:</p> <p>3 Q. So as an expert in geology, you can't</p> <p>4 tell me as a fact, sitting here today, that there are</p> <p>5 some talc deposits that are exist in the world that are</p> <p>6 comprised of more talc than others?</p> <p>7 MS. SCOTT: Objection. Asked and</p> <p>8 answered.</p> <p>9 A. I think I answered that, yeah. There's</p> <p>10 some that have a higher percentage of talc, but there's</p> <p>11 impurities that also occur. So, you know, if you have</p> <p>12 10 percent asbestos in one mine and 2 percent asbestos</p> <p>13 in one and 30 percent in another, so, yes, that's,</p> <p>14 that's possible.</p> <p>15 BY MR. FROST:</p> <p>16 Q. I don't think you're understanding my</p> <p>17 question. More fundamentally, don't you agree with me</p> <p>18 some talc deposits are only made up of 20 percent talc</p> <p>19 and are predominantly other minerals, as were other talc</p> <p>20 deposits are made up of, for example, 50 or 60 percent</p> <p>21 talc?</p> <p>22 A. So I'm unclear. Are you talking about</p> <p>23 talc deposits or talc ores?</p> <p>24 Q. I'm talking about talc deposits,</p> <p>25 generally, geological formations of talc.</p>
<p style="text-align: right;">Page 67</p> <p>1 you need to analyze each individual deposit.</p> <p>2 BY MR. FROST:</p> <p>3 Q. As an expert in geology, you can't tell</p> <p>4 me that there are some deposits of talc in the world</p> <p>5 that are more pure than others, that are more comprised</p> <p>6 of talc than others?</p> <p>7 MS. SCOTT: Objection.</p> <p>8 A. One would expect -- you know, so</p> <p>9 materials are variable in percentages, but I don't think</p> <p>10 it's reasonable just to declare -- I mean, it seems like</p> <p>11 a -- perhaps I'm misinterpreting it, but it seems like a</p> <p>12 arbitrary setup or question. So the -- one cannot --</p> <p>13 what I'm trying to say is one cannot predict the exact</p> <p>14 impurities in any given deposit.</p> <p>15 There are general -- using the</p> <p>16 peer-reviewed literature and well documented, you know,</p> <p>17 work of archives going back, for example, Hess, 1933,</p> <p>18 you know, it is common and reasonable to know that</p> <p>19 there's some, or very, very likely, asbestos materials</p> <p>20 are associated with talc.</p> <p>21 And so it is reasonable that -- it's a</p> <p>22 reasonable, scientifically reasonable interpretation</p> <p>23 that one would expect impurities of many types, but they</p> <p>24 may not be the same. So we have examples where there's</p> <p>25 tremolite, and there's examples where there's</p>	<p style="text-align: right;">Page 69</p> <p>1 A. So, yeah. Talc can occur at a variable</p> <p>2 concentration in metamorphic rocks.</p> <p>3 Q. You will also agree with me that some</p> <p>4 talc deposits can be larger than others, right,</p> <p>5 geologically?</p> <p>6 A. Yes.</p> <p>7 Q. You'll agree with me that talc is sort of</p> <p>8 all over the place and what are the mine deposits are</p> <p>9 sort of unique?</p> <p>10 A. No. Talc is not all over the place.</p> <p>11 Metamorphic rocks comprise approximately 10 percent or</p> <p>12 so of rocks exposed at the surface of the earth, and so</p> <p>13 talc, by that definition alone, talc is not all over the</p> <p>14 place.</p> <p>15 Q. You'd agree with me talc can be found</p> <p>16 from Quebec to Georgia, for example?</p> <p>17 A. I think that's a very general in, perhaps</p> <p>18 in consumers' homes, in baby powder bottles. The --</p> <p>19 Q. You don't think there are talc formations</p> <p>20 found in the Appalachian Mountains from Quebec through</p> <p>21 Georgia?</p> <p>22 A. There --</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. There are other talc deposits in North</p> <p>25 America, yes. They're not restricted to Vermont, but</p>

<p style="text-align: right;">Page 70</p> <p>1 talc deposits do occur. 2 BY MR. FROST: 3 Q. And talc deposits occur in places like 4 Alabama, Texas, Minnesota, California? You'll agree 5 with me on that as well, right? 6 A. I remember some of the specifics in the 7 Southern states. I know they occur in California. 8 Q. Will you agree with me that some talc 9 deposits are larger than others? 10 MS. SCOTT: Objection. 11 A. Yes. You can have small talc deposits. 12 You can have big talc deposits. You can have -- they're 13 just like granites. You can have small granites and 14 large granites. You can have -- you know, a variation 15 in size and scale and complexity is a very common trait 16 in geologic terrains. 17 BY MR. FROST: 18 Q. You'd agree with me because of variations 19 in size, scale, complexity, accessory minerals, et 20 cetera, you can't make general statements about talc 21 deposits. Not every talc deposit's the same, right? 22 MS. SCOTT: Objection. 23 A. To some level, I think one can. You can 24 make general statements about rock types, what is common 25 or likely to occur. If we were able to precisely</p>	<p style="text-align: right;">Page 72</p> <p>1 but you can have minerals that have fibrous habits that 2 are not microscopic. 3 So an example would be millerite, which 4 is a nickel sulfide that, essentially, you have these 5 very long black fibers, and it's very commonly -- that's 6 what it occurs as. And the fiber -- fibrous textures, 7 you know, essentially, all morphologies are driven by 8 the unit cell and, essentially, bonding strengths and 9 defect densities and things like that. So fibers are 10 common in asbestiform materials. 11 Q. Is a fibrous habit different than the 12 asbestiform habit? 13 A. So a fiber would be more of a subset of 14 asbestiform. So if I had a chunk of chrysotile, that 15 would be asbestiform, and it would be composed of 16 fibers. 17 Q. So fibers are a smaller subset of 18 asbestiform? 19 A. Generally. 20 Q. Can you define for me what "asbestiform 21 habit" means? Are you able to define what "asbestiform 22 habit" means without referencing your report? 23 A. Asbestiform basically is -- 24 Q. Here, could we do it this way? Without 25 looking at your report, can you define for me what</p>
<p style="text-align: right;">Page 71</p> <p>1 predict just by thought the distribution of ore, we 2 would have no problem finding platinum and gold and 3 those kinds of things, right? So does that answer the 4 question? 5 Q. Sure. 6 THE WITNESS: Can we take a break? 7 MR. FROST: Sure. 8 VIDEOGRAPHER: We are now going off 9 record, and the time is 10:48. 10 (A recess was taken from 10:48 to 11:03.) 11 VIDEOGRAPHER: We are now back on record, 12 and the time is 11:03. 13 BY MR. FROST: 14 Q. Would you describe for me what a "fibrous 15 habit" means? 16 A. In general, it is an elongated particle 17 that -- and the -- so on page 4, I indicate there's 18 length or width ratios for fibers which have fibrous 19 habit of three to one, and then NIOSH is five to one. 20 BY MR. FROST: 21 Q. Okay. Can you define for me what a 22 "fibrous habit" means? Does it purely mean dimensions 23 of three to one to five to one? 24 A. So in the general context of mineralogy, 25 fiber can -- it's actually a little bit of a loose term,</p>	<p style="text-align: right;">Page 73</p> <p>1 "asbestiform" means? 2 MS. SCOTT: Objection. If he needs to 3 look at his report, he can look at his report. 4 MR. FROST: Well, I just want to see if 5 he can do it without looking at the report. 6 BY MR. FROST: 7 Q. But if you need to look at your report, 8 just let me know that you have to look at your report to 9 define it. 10 MS. SCOTT: Objection. 11 A. Asbestiform essentially is a texture that 12 is -- the particles are elongated. They have a high 13 general aspect ratio. 14 BY MR. FROST: 15 Q. So asbestiform is purely a texture? 16 MS. O'DELL: Object to the form. 17 A. A texture with respect to what? 18 BY MR. FROST: 19 Q. Well, that's what you just said. That's 20 what I'm trying to figure out. You used the word 21 "texture." You defined asbestiform as a texture? 22 A. So texture is a general term that means 23 the size, shape and distribution of mineral particles. 24 Q. Is that different than the morphology? 25 A. Morphology generally refers to a crystal</p>

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1 or single phase.
2 Q. What do you mean by that, the "single
3 phase"?
4 A. Single phase, phase is like a -- phase is
5 a thermodynamic term. So, in theory, it is something
6 that is separable from a system. So you can have
7 something like chrysocolla that is grown around and fill
8 some other mineral, where you can have glass. Glass is
9 a separate phase. Or it can also be a mineral, so it's
10 more of just a thermodynamic term.
11 Q. Do you agree with me that in order for a
12 mineral to be asbestiform, it has to grow in an
13 asbestiform habit?
14 MS. SCOTT: Objection.
15 A. No. So talc is mechanically soft, and I
16 can certainly imagine scenarios where you have
17 tremolite, large tremolite crystals that exist in a talc
18 schist, and that talc schist then experiences continued
19 dynamic metamorphism, so things move, and that talc
20 crystal can be -- other talc -- or, I'm sorry, the
21 tremolite crystal in the talc can then hit other talc or
22 other tremolite crystals and essentially abrade and
23 grind and be broken down into smaller elongate, elongate
24 mineral particles which would be fibrous, and that would
25 be one way of producing that texture.

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1 BY MR. FROST:
2 Q. Is that different than growing in an
3 asbestiform habit? In order to be asbestiform, do you
4 have to grow in the asbestiform habit?
5 MS. SCOTT: Objection.
6 A. There's not necessarily -- mineral growth
7 would not necessarily be a part of that.
8 BY MR. FROST:
9 Q. So mineral growth has nothing to do with
10 whether or not a mineral is asbestiform?
11 MS. SCOTT: Objection.
12 A. I think there's a false dilemma. You
13 know, as I described, so you can have that, you know, a
14 nice, happy actinolite or tremolite crystal. Stress is
15 applied during metamorphism and that then breaks apart
16 and you can end up with material that is -- that meets
17 the definition of a fiber.
18 BY MR. FROST:
19 Q. So as far as you're concerned, all fibers
20 are asbestiform?
21 MS. SCOTT: Objection.
22 A. No. My mineral, one of the minerals I'm
23 an expert in, palygorskite/sepiolite, often the
24 individual crystals are referred to as fibers.
25

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1 BY MR. FROST:
2 Q. If you look at page 4 of your report,
3 second paragraph, under "Asbestos," you write that
4 "Asbestiform refers to a mineral that has grown into a
5 fibrous aggregate of long, thin flexible crystals that
6 readily separate into smaller crystals of a" smaller
7 "length-to-width aspect ratio." You agree with me
8 that's very different than what you just told me, right?
9 MS. SCOTT: Objection. You just misread
10 something. It says, "smaller crystals of a
11 similar length."
12 MR. FROST: Oh, I apologize.
13 MS. SCOTT: No problem.
14 A. So I think that's a correct statement.
15 BY MR. FROST:
16 Q. Which one, the one in your report or the
17 one you just gave me?
18 MS. SCOTT: Objection.
19 A. Both.
20 BY MR. FROST:
21 Q. You think you can, a mineral can both
22 grow as you have here in a fibrous aggregate of long or
23 you can create it?
24 A. It can -- it can result from the process.
25 So in the broad context, if you are crushing or milling

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1 a talc ore and there's tremolite in it, basically, you
2 can process that, it's my expert opinion, that you can
3 process that and result in producing asbestiform
4 materials or fibers, elongated mineral particles.
5 Q. So are all elongated mineral particles
6 asbestiform?
7 A. I'm sorry. I misspoke. Not necessarily,
8 no.
9 Q. Okay. Why don't we look at -- well,
10 first off, do you have any studies or research that you
11 rely on to support your opinion that you can change
12 something that grew prismatic into something that's now
13 asbestiform?
14 A. So I think it's reasonable, based on my
15 knowledge of crystal chemistry.
16 Q. You can't point me to a single
17 peer-reviewed study or NIOSH or anything else that has
18 ever supported this opinion?
19 MS. SCOTT: Objection.
20 A. So I was taught by Steve Guggenheim that
21 you can reduce particle size, and when you reduce
22 particle size in minerals, essentially, that is driven
23 by cleavage. So basically every mineral has a unit
24 cell, and that is definition of the elements that are
25 unique to that mineral and a specific arrangement.

<p style="text-align: right;">Page 78</p> <p>1 And, essentially, the nature of bonds in 2 that mineral will be weaker along certain planes for 3 certain minerals such as amphiboles. So basically what 4 happens is when you apply stress, it doesn't matter if 5 that is a five-foot piece of tremolite or if it is a 6 micron piece of tremolite. Essentially, it's absolutely 7 reasonable that if you apply stress and you break that, 8 it will break into smaller pieces, and you can end up 9 with -- essentially, the hat or the shape is the same. 10 Or, essentially, hat or shape is driven by those 11 crystallographic parameters. 12 BY MR. FROST: 13 Q. All right. Do you know what a cleavage 14 fragment is? 15 A. Yeah. It's essentially a fragment that 16 has broken off. 17 Q. And you're telling me that cleavage 18 fragments can be asbestiform that have broken off as 19 prismatic crystals? 20 A. I think they can, so they can. They can 21 meet the crystallographic requirements. 22 Q. Is your opinion generally accepted by the 23 scientific community? 24 A. I have not presented or published on 25 that, but I think, based on my experience and what I</p>	<p style="text-align: right;">Page 80</p> <p>1 particular particle is asbestiform or a cleavage 2 fragment, and your answer to that was cleavage fragments 3 implies that through some mechanism process, it's been 4 developed. That's what I'm asking. What is this 5 mechanism process? Is this an outside force? Are you 6 talking about processing -- 7 A. Mechanical. 8 Q. You're talking about mechanics. So if a 9 fragment cleaves off because a mechanical force is 10 applied to it, it's a cleavage fragment? If it occurs, 11 if it naturally cleaves, then it's asbestiform? 12 MS. SCOTT: Objection. 13 A. You can have, as I mentioned before, you 14 can have the situations totally reasonable, both in the 15 processing and then the natural geologic process, where 16 you can have a tremolite crystal, for example, that 17 essentially is deformed through metamorphic processes. 18 You can have multiple directions of force, and so, 19 basically, you can end up with particles that are 20 asbestiform as a result of that, and then you can grind, 21 crush, process things that also have an asbestiform 22 texture. 23 BY MR. FROST: 24 Q. Are there any standards you're relying on 25 to make this determination of asbestiform versus</p>
<p style="text-align: right;">Page 79</p> <p>1 know about crystal chemistry of minerals, that is a 2 reasonable interpretation. 3 Q. Okay. So your interpretation is that a 4 particle can become asbestiform, even if it didn't form 5 naturally in an asbestiform habit by this cleaving down 6 to a particular particle size? Is that a fair summary? 7 MS. O'DELL: Object to the form. 8 A. You, through processing, you can modify 9 many things. 10 BY MR. FROST: 11 Q. So can you tell me what particular 12 properties will determine whether or not a particle was 13 a cleavage fragment versus an asbestiform fragment? 14 MS. SCOTT: Objection. 15 A. Cleavage fragment implies that it has, 16 through some mechanical process, it's been developed. 17 BY MR. FROST: 18 Q. So a cleavage fragment purely refers to 19 some outside mechanical process? 20 MS. SCOTT: Objection. 21 A. What do you mean by "purely"? 22 BY MR. FROST: 23 Q. That's what I'm trying to figure out, 24 what your definition is. So I asked you, you know, what 25 the properties are that will determine whether or not a</p>	<p style="text-align: right;">Page 81</p> <p>1 cleavage fragment? 2 MS. SCOTT: Objection. 3 A. I'm using the terminology as described in 4 my mineralogy class that I took from Dr. John Grover in 5 1991, and he -- he grew some of the artificial, 6 synthetic fibers for the rat tests in the '70s. 7 BY MR. FROST: 8 Q. Okay. Other than this class you had with 9 Dr. John Grover, you can't name me another source, 10 another peer-reviewed literature, a scientific paper 11 that supports your theory? 12 MS. SCOTT: Objection to form. 13 MR. LAPINSKI: I was going to say, make 14 sure you let him ask the full question before 15 you start to answer. 16 THE WITNESS: Okay. I'm sorry. 17 BY MR. FROST: 18 Q. Do you want me to reask it? 19 A. The terms were used in my graduate school 20 classes as well. I think that -- yeah. 21 Q. And your opinion is whether or not this 22 fragment that breaks off, whether or not it's 23 asbestiform or cleavage doesn't have anything to do with 24 the way in which the particle originally formed? 25 MS. SCOTT: Objection.</p>

<p style="text-align: right;">Page 82</p> <p>1 A. So crystallographically, in a way, the 2 term's not necessarily extremely relevant. It is the 3 physicality of a particle is such that, you know, it's 4 driven by, essentially, the science. So you can crush, 5 you can grind something, and you can end up with an 6 asbestiform particle. 7 MR. FROST: Let me look at some articles. 8 I'm going to mark this as -- I believe, we're at 9 Exhibit 3. 10 (Exhibit 3 was marked for 11 identification.) 12 BY MR. FROST: 13 Q. Do you recognize this paper? 14 A. No, I do not. I have not seen this 15 report. 16 Q. This is not the IRSST 2010 Montreal paper 17 you reference in your report? 18 A. I don't remember. 19 Q. Look at your -- let me see. I want to 20 find a place that you reference this. If you look at 21 Footnote 5 on page 4. 22 A. I don't see a Footnote 5 on page 4. 23 Q. Of your report. 24 MS. SCOTT: Of your report. 25 A. Oh, I'm sorry. Okay. Yeah.</p>	<p style="text-align: right;">Page 84</p> <p>1 high aspect ratio, (length/diameter ratio), increased 2 mechanical properties, flexibility and durability. 3 "In the asbestiform morphology, the 4 crystals grew by forming long and filiform fibers. 5 These fibers are found in bundles that can easily 6 separate into smaller fibers (fibrils), which, during 7 processes, retain their surface and activity properties. 8 "OSHA (1992) specifies that the 9 asbestiform criterion does not depend on the crystalline 10 structure but on how the crystal grows or its 11 crystalline formation. When pressure is applied to" an 12 asbestiform "fiber, it will bend rather than break." 13 Did I read that correctly? 14 MS. SCOTT: With one correction. 15 MR. FROST: I did miss one? 16 MS. SCOTT: Asbestos fiber, not 17 asbestiform fiber. 18 MR. FROST: Oh, I apologize. 19 BY MR. FROST: 20 Q. Did I read that -- other than that, did I 21 read this correctly? 22 A. Okay. Yeah. 23 Q. Do you agree with me this definition is 24 very different than the definition you've given me? 25 MS. SCOTT: Objection.</p>
<p style="text-align: right;">Page 83</p> <p>1 BY MR. FROST: 2 Q. Do you agree that this is the same report 3 that you have referenced in Footnote 5 on your paper? 4 A. Yeah. 5 Q. Have you ever read this report before? 6 A. I think so. 7 Q. And this is something -- 8 A. I'm tired. 9 Q. And this is something you rely on 10 otherwise in your paper, correct? 11 A. I forget the specifics of where I've 12 cited it. 13 Q. If you turn to page 10, please. 14 MS. SCOTT: Of the report or of the -- 15 MR. FROST: Of the paper, the IRSST 16 paper. 17 A. Page 10. 18 BY MR. FROST: 19 Q. So it's Section 5.1.2, "Asbestiform." 20 A. Okay. 21 Q. It states, "The term 'asbestiform; refers 22 to a morphology originating from the natural 23 crystallization of a mineral into small crystals, into 24 hair-like fibers (unidimensional). This morphology 25 gives the mineral-specific characteristics, including a</p>	<p style="text-align: right;">Page 85</p> <p>1 A. Not necessarily. It is more specific, 2 but it's, you know, generally in line. 3 BY MR. FROST: 4 Q. Generally in line. Doesn't the IRSST 5 paper specifically state that an asbestiform crystal has 6 to grow into that structure to be asbestiform? 7 A. It says that, but again -- 8 Q. You disagree with that? 9 MS. SCOTT: Objection. 10 A. It -- 11 BY MR. FROST: 12 Q. It's okay. You can disagree with it. 13 A. In my -- it's permissive, not exclusive. 14 So I - I -- 15 Q. I don't -- where does it say it's 16 permissive, not exclusive? Is that in this paper? 17 A. No. My class terminology might not be 18 consistent with this. 19 Q. Okay. Let's look at another one. What 20 exhibit are we on? Four? I would like to mark this as 21 Exhibit 4. I'll give you a copy. 22 MR. FROST: Are we not on four? 23 MS. SCOTT: I think it's five. 24 MR. FROST: Are we on five? I thought we 25 were on five, too.</p>

<p style="text-align: right;">Page 86</p> <p>1 MS. SCOTT: I think we're on five.</p> <p>2 MR. FROST: Okay. Yeah. I was going to</p> <p>3 say maybe we can keep track.</p> <p>4 VIDEOGRAPHER: I'm keeping track, but the</p> <p>5 last one you just gave him, you said three.</p> <p>6 MR. FROST: Oh, okay. So I guess we are</p> <p>7 on 4. We'll mark this whatever the next exhibit</p> <p>8 is.</p> <p>9 (Exhibit 4 was marked for</p> <p>10 identification.)</p> <p>11 BY MR. FROST:</p> <p>12 Q. Take a look at it. Have you ever seen</p> <p>13 this paper before?</p> <p>14 A. I'm not sure. I immediately don't see it</p> <p>15 in the reference list.</p> <p>16 Q. I can tell you, it's not on your</p> <p>17 reference list.</p> <p>18 A. Okay. Yeah. I have not seen this</p> <p>19 before.</p> <p>20 Q. Have you ever heard of Dr. William J.</p> <p>21 Campbell?</p> <p>22 A. No, I have not.</p> <p>23 Q. You'd agree with me that this is a report</p> <p>24 from the United States Department of the Interior,</p> <p>25 Bureau of Mines?</p>	<p style="text-align: right;">Page 88</p> <p>1 that are related to the crystal structure and are always</p> <p>2 parallel to crystal faces." That's in line with what</p> <p>3 you've described, right, for cleaving?</p> <p>4 A. That statement is not correct.</p> <p>5 Q. It's not correct?</p> <p>6 A. You can have cleavage that is, has a</p> <p>7 variety of degree as a perfection to it.</p> <p>8 Q. And, again, do you have -- can you cite</p> <p>9 me a study that you're relying on for that opinion?</p> <p>10 A. I can probably point to a book, but it's</p> <p>11 something that is -- I mean, it's taught in mineralogy,</p> <p>12 introduction to mineralogy. You have different levels</p> <p>13 of perfection of cleavage. So, for example, micas are</p> <p>14 said to be perfect in cleavage, and a lot of the</p> <p>15 amphiboles are said to be good but not necessarily</p> <p>16 perfect.</p> <p>17 And, actually, you can see in this SEM</p> <p>18 image, there's all kinds of irregularities on the</p> <p>19 surface. And on this particular SEM image, it's</p> <p>20 extremely bright. The contrast is wrong. It's not --</p> <p>21 you know, you can't tell what is on that right end of</p> <p>22 the image that is the tremolite particle there.</p> <p>23 Q. I'll stop you here. I'm confused because</p> <p>24 your problem with the definition appears to be the word</p> <p>25 "perfect," which doesn't actually appear in the</p>
<p style="text-align: right;">Page 87</p> <p>1 A. Yes.</p> <p>2 Q. You'd agree with me that they are a</p> <p>3 reliable source --</p> <p>4 A. So this is from 1977?</p> <p>5 Q. Yes. You'd agree with me that the Bureau</p> <p>6 of Mines is a reliable source of information for</p> <p>7 geological term -- geological --</p> <p>8 A. I am somewhat hesitant's to make a</p> <p>9 generalization of any organization being extremely</p> <p>10 reliable or not. It depends on the individual. But,</p> <p>11 generally, many things that have been produced are</p> <p>12 reliable. This document is from 1977, which is sort of</p> <p>13 the end of the heyday of asbestos production. So right</p> <p>14 around this time, essentially, it was coming to light</p> <p>15 that asbestos really did have a lot of hazards</p> <p>16 associated with it.</p> <p>17 Q. Can you please turn to page 30 of this</p> <p>18 report? Specifically, there's a the paragraph, it's</p> <p>19 called "Cleavage Fragment." Do you see where I'm</p> <p>20 talking about?</p> <p>21 A. Yes.</p> <p>22 Q. Okay. If you go down to the second -- I</p> <p>23 can read the first few on, but -- I'll read all of it</p> <p>24 for clarity. "Cleavage fragment: A fragment produced</p> <p>25 by the breaking of crystals in" direct -- in "directions</p>	<p style="text-align: right;">Page 89</p> <p>1 definition. But you generally agree that a cleavage</p> <p>2 fragment is a cleave along a generally parallel plane of</p> <p>3 a crystalline structure, right?</p> <p>4 A. Yes.</p> <p>5 Q. Okay. If you continue along, it says,</p> <p>6 "Minerals" --</p> <p>7 A. It says "with perfect cleavage."</p> <p>8 Q. That's in the next, you know, paragraph.</p> <p>9 A. I'm sorry. I got confused.</p> <p>10 Q. So it talks a little bit, you know, about</p> <p>11 it. It talks about amphiboles, et cetera. What I'm</p> <p>12 concerned is the next paragraph down. It starts,</p> <p>13 "However, because they did not grow as fibers, they</p> <p>14 cannot have characteristics of fibers. Consequently,</p> <p>15 cleavage fragments cannot be called fibers."</p> <p>16 Do you see where the Bureau of Mines has</p> <p>17 said that?</p> <p>18 MS. SCOTT: Object to form.</p> <p>19 A. So it's my professional opinion that</p> <p>20 that's inaccurate. I mean, the crystallographic -- you</p> <p>21 know, from the materials aspect of things, whether</p> <p>22 something has grown or not, you know, doesn't -- it</p> <p>23 really doesn't matter too much as far as what it is. So</p> <p>24 and -- and so, "However, because they did not grow as</p> <p>25 fibers, they cannot have characteristics of fibers."</p>

<p style="text-align: right;">Page 90</p> <p>1 Well, you know, if you can cleave or process something, 2 roll it such that, you know, you get particle size 3 reduction, and that particle size is then, matches, 4 although perhaps there is disagreement on what 5 asbestiform is, but it matches what a fiber is, then 6 that's -- 7 BY MR. FROST: 8 Q. But, again, you can't point me to a 9 single study or peer-reviewed piece of literature that 10 supports your opinion, correct? 11 MS. SCOTT: Objection. 12 A. I think it's -- I think it's a very much 13 a reasonable interpretation. It's almost too basic, in 14 a way. I mean, if we know -- we're taught, actually, at 15 the introductory level, that minerals cleavage is the 16 first things we teach, and essentially cleavage is an 17 interval property of a given mineral, and then you can 18 reduce it, and that's why minerals, when you crush a 19 mineral, you actually, you have sort of the same general 20 kind of particle shape. So you take mica, for example, 21 and you crush it and you get a particle size reduction, 22 and a lot of that is happening along the cleavage 23 planes. So I think -- 24 BY MR. FROST: 25 Q. So that's what I established. So you</p>	<p style="text-align: right;">Page 92</p> <p>1 A. Yes, I believe this is what's cited in 2 the report. This is the 2010 IARC. 3 Q. Can you please turn to page 277? If you 4 look at the bottom paragraph, it says, "Asbestos is a 5 commercial term that describes six minerals that occur 6 in the asbestiform habit: Actinolite, anthophyllite, 7 chrysotile, grunerite, riebeckite and tremolite (IARC, 8 1977). Similarly to talc, these six minerals occur more 9 commonly in a non-asbestiform habit and may also be 10 elongated without being asbestiform." And then if you 11 follow down, it says, "when asbestiform, they constitute 12 asbestos and, when not asbestiform, they are referred to 13 as mineral fragments or cleavage fragments." 14 So, again, here, IARC is talking about 15 how the crystal forms or how it grows to distinguish 16 asbestiform versus cleavage fragment, correct? 17 MS. SCOTT: Objection. 18 A. So you're saying as it forms? 19 BY MR. FROST: 20 Q. Yes. 21 A. So mechanical processes can be how a 22 mineral is formed or how a texture is developed. 23 Q. So you're saying the cleave of a 24 prismatic crystal can considered the morphology of how 25 that crystal forms?</p>
<p style="text-align: right;">Page 91</p> <p>1 think IRSST is wrong. You think the Bureau of Mines is 2 wrong, right? 3 MS. SCOTT: Objection. 4 BY MR. FROST: 5 Q. Why don't we look at the World Health 6 Organization? 7 MR. FROST: This is -- I'll mark this as 8 Exhibit 5. 9 MS. O'DELL: Monograph 93. 10 MR. FROST: Yes, it's Monograph 93. 11 Sorry. 12 (Exhibit 5 was marked for 13 identification.) 14 A. So this would be IARC 2010. 15 MR. FROST: Does anyone need a copy or 16 pull it up on your computer? 17 MS. SCOTT: Yeah. 18 MR. FROST: That's a better way to look 19 at it. 20 MR. FERGUSON: I'll take one, Jack, if 21 you've got an extra one. 22 MR. FROST: I do. 23 MR. FERGUSON: Lighten your load. 24 BY MR. FROST: 25 Q. Are you familiar with this publication?</p>	<p style="text-align: right;">Page 93</p> <p>1 A. No. You said how a mineral -- what did 2 you say? 3 Q. Yes, that's what I said is how a mineral 4 forms. This is what they're saying: A mineral can 5 form -- 6 A. So -- 7 Q. -- an asbestiform habit or not. 8 A. -- form is not growth. Form is not 9 growth. 10 Q. Okay. Fine. It's saying here that how a 11 crystal grows or develops determines whether or not it's 12 is a mineral fragment or asbestiform, correct? 13 MS. SCOTT: Objection. 14 MS. O'DELL: Object to the form. 15 A. "When asbestiform, they constitute 16 asbestos, and when not asbestiform, they are referred to 17 as mineral fragments or cleavage fragments." That's how 18 they are referred to. But I don't see anything in here 19 about growth. There's nothing about precipitating out 20 of a solution. There's nothing precipitating out of a 21 melt. There's nothing precipitating from some 22 mineralogical transformation. So -- and, again, you 23 know -- 24 BY MR. FROST: 25 Q. But, again, I just want to go back.</p>

<p style="text-align: right;">Page 94</p> <p>1 A. -- cleavage --</p> <p>2 MR. LAPINSKI: Let him finish his answer.</p> <p>3 MR. FROST: Sure.</p> <p>4 A. Whether something is a cleavage or</p> <p>5 fragment or not, it can be -- it can match the</p> <p>6 dimensions of something that is defined by NIOSH or</p> <p>7 other things. It can be 1 micron by 3 microns or it can</p> <p>8 be 1 micron by 5 microns. So I don't -- the -- you</p> <p>9 know. But this, this doesn't seem to -- you keep</p> <p>10 implying that there has to be growth for the mineral to</p> <p>11 occur, but it's not -- apparently, in here, it doesn't,</p> <p>12 it doesn't make that stipulation.</p> <p>13 Grinding, grinding can be one method, and</p> <p>14 then deformation. We have other examples where,</p> <p>15 essentially, textures are developed from deformation,</p> <p>16 meteorite impacts. We have metamorphic rocks. We can</p> <p>17 have, essentially, high temperature or high pressure</p> <p>18 metamorphic rocks that have one form of quartz in them.</p> <p>19 Then when they get exhumed, essentially, they shatter</p> <p>20 the granite around them and create a different texture.</p> <p>21 So I don't, I don't think that growth is</p> <p>22 necessarily related to -- I think, in my professional</p> <p>23 opinion, it's not related to the generation of cleavage</p> <p>24 fragments, and it's my professional opinion that</p> <p>25 cleavage fragments can have asbestiform materials.</p>	<p style="text-align: right;">Page 96</p> <p>1 question.</p> <p>2 A. -- activity --</p> <p>3 Q. Let me ask you a question. Let me ask</p> <p>4 you the question without reading from the thing, because</p> <p>5 you're reading the phonetics, which aren't actually the</p> <p>6 question I'm asking.</p> <p>7 A. Okay. I'm sorry.</p> <p>8 Q. What properties, other than size, will</p> <p>9 tell you whether or not a particle is a cleavage</p> <p>10 fragment versus an asbestiform fiber?</p> <p>11 A. What properties other than size?</p> <p>12 Q. I guess size truly -- is that what</p> <p>13 determines whether or not a particle is asbestiform</p> <p>14 versus a cleavage fragment, in your opinion?</p> <p>15 MS. SCOTT: Objection.</p> <p>16 A. It's a major, a major factor in it. But,</p> <p>17 you know, you can have things that are large that are</p> <p>18 asbestiform as well. So hand samples, images in --</p> <p>19 Q. Okay. Can you answer my question? Is it</p> <p>20 a major component or is that the difference? And if</p> <p>21 there's more than just size, what are the other things</p> <p>22 you look at to determine whether or not a particle is a</p> <p>23 cleavage fragment versus an asbestiform fiber?</p> <p>24 MS. SCOTT: Objection. He is answering</p> <p>25 your question. Go ahead, Doctor.</p>
<p style="text-align: right;">Page 95</p> <p>1 The other thing that confuses things is</p> <p>2 you can have a cleavage fragment that's a meter, right?</p> <p>3 You can -- you can have large crystals. You can go out</p> <p>4 to the South Dakota mines and pick up a spodumene, hit</p> <p>5 it with a hammer. That's a cleavage fragment. Because</p> <p>6 we have these same atomic laws, essentially, you get the</p> <p>7 same type of effects into the small particle ranges.</p> <p>8 Q. So now I'll go back to the same question</p> <p>9 I asked before you couldn't answer, and that was, other</p> <p>10 than size, other than this whole idea of aspect ratio,</p> <p>11 what other differences can you tell me there is between</p> <p>12 an asbestiform fiber and a cleavage fragment? Is it</p> <p>13 truly just size, in your opinion, that makes something</p> <p>14 asbestiform?</p> <p>15 MS. SCOTT: Object to the form of the</p> <p>16 question. You can answer.</p> <p>17 BY MR. FROST:</p> <p>18 Q. It's an easy enough question. I'll ask</p> <p>19 it a different way if you want.</p> <p>20 A. I'm a slow reader. Sorry. What</p> <p>21 differences can you tell me there is between asbestiform</p> <p>22 fiber around achieve advantage fragment -- a cleavage</p> <p>23 fragment. So if you're talking about just differences</p> <p>24 in general --</p> <p>25 Q. Well, no. That's why. Let me ask you a</p>	<p style="text-align: right;">Page 97</p> <p>1 BY MR. FROST:</p> <p>2 Q. I don't understand how telling me the</p> <p>3 size of giant pattern, giant rocks that are grabbed from</p> <p>4 somewhere else. What I want to know are what properties</p> <p>5 do you look at when you're trying to determine if it's</p> <p>6 an asbestiform fiber versus a cleavage fragment? Is it</p> <p>7 just the size of the mineral with -- you know, the</p> <p>8 aspect ratio of the mineral? Is that purely what</p> <p>9 determines, in your opinion, whether a particle is</p> <p>10 asbestiform versus cleavage?</p> <p>11 A. That and the texture.</p> <p>12 Q. What do you mean by "texture"? What</p> <p>13 properties are you looking at in the texture?</p> <p>14 A. The texture is how -- is the size, shape</p> <p>15 and distribution of materials.</p> <p>16 Q. So, again, we're talking about size,</p> <p>17 shape and distribution. These are the only -- these are</p> <p>18 the aspects --</p> <p>19 A. I get that from -- I'm sorry.</p> <p>20 Q. I was going to say, size, shape and</p> <p>21 distribution are the attributes you look at to determine</p> <p>22 whether or not a particle is asbestiform versus</p> <p>23 cleavage?</p> <p>24 A. A spatial distribution is not necessarily</p> <p>25 size and shape.</p>

<p style="text-align: right;">Page 98</p> <p>1 Q. What do you mean by "spatial 2 distribution," then?</p> <p>3 A. The occurrence of it in a sample or 4 substrate.</p> <p>5 Q. What do you mean by "occurrence of it in 6 a sample or substrate"?</p> <p>7 A. The placement of it. So, essentially, we 8 can have a lithology onto which, relative to that, an 9 asbestiform material occurs.</p> <p>10 Q. What do you mean by lithology upon which 11 an asbestiform material occurs?</p> <p>12 A. Lithology is a general term for a type of 13 rock. It's a very general term for a type of rock.</p> <p>14 Q. Okay. So, effectively, you're saying the 15 type of rock it is and the size and shape of the 16 particle determine whether or not it's asbestiform? 17 Those are the three considerations you look at?</p> <p>18 A. Well, so, not necessarily, but, you know, 19 I'm talking about hand sample size.</p> <p>20 Q. Okay. And this is -- and what about -- 21 and what about micron size, when you're looking at a 22 particle that's micron size?</p> <p>23 A. Aspect ratio is important. I think that 24 and -- so to identify a fiber or a cleavage fragment, to 25 thoroughly identify things, one should generally do,</p>	<p style="text-align: right;">Page 100</p> <p>1 between a cleavage fragment and an asbestiform fiber?</p> <p>2 Q. Yes.</p> <p>3 A. A cleavage fragment can be a subset of 4 asbestiform fibers.</p> <p>5 Q. So you're telling me there's no 6 difference between a cleavage fragment and asbestiform 7 fiber if it's --</p> <p>8 A. No.</p> <p>9 Q. -- if they're the same size?</p> <p>10 A. If it's --</p> <p>11 MS. SCOTT: Let him finish.</p> <p>12 BY MR. FROST:</p> <p>13 Q. If they meet whatever aspect ratio 14 definition you want to put on it, as far as you're 15 concerned, any cleavage fragment that meets that 16 definition is an asbestiform fiber?</p> <p>17 MS. SCOTT: Objection.</p> <p>18 A. Speculative in that I don't -- you know, 19 I don't --</p> <p>20 BY MR. FROST:</p> <p>21 Q. It's not speculative. I'm asking for 22 your definition.</p> <p>23 A. I'm sorry. I have an incomplete thought. 24 A cleavage fragment can be a subset of -- it can be a 25 subset of an asbestiform fiber.</p>
<p style="text-align: right;">Page 99</p> <p>1 should do TEM work. And in order for that data to be 2 interpreted, to identify the aspect ratio and also what 3 the material is, you need to do imaging electron 4 diffraction and electron microscopy.</p> <p>5 Q. Okay. I fear you're not understanding my 6 question. I'm not -- I want to know what the difference 7 is between an asbestiform particle and a cleavage 8 fragment. Is it purely the aspect ratio and the type of 9 rock it's generated from, in your opinion?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. I'm sorry. I'm having difficulty 12 describing it. I thought I described it. I thought I 13 answered.</p> <p>14 BY MR. FROST:</p> <p>15 Q. What you keep saying is you keep telling 16 me is that aspect ratio is a major component. Is it the 17 only component? Are there others? We've heard the type 18 of rock. Are there any other things you would look at 19 to tell me these are the properties of an asbestiform 20 fiber versus these are the properties of a cleavage 21 fragment? I'm just asking for simple mineralogic 22 definition here of what's the difference between a 23 cleavage fragment and an asbestiform fiber. If it's 24 rock type and aspect ratio, that's fine.</p> <p>25 A. So, okay. So what's the difference</p>	<p style="text-align: right;">Page 101</p> <p>1 Q. How? Like how do you -- so what -- okay.</p> <p>2 A. Based on the size and the dimensions that 3 are provided in the paragraph in page 4.</p> <p>4 Q. Okay. So it's purely size and dimension 5 is what determines whether or not a cleavage fragment is 6 a subset of asbestiform?</p> <p>7 A. Correct.</p> <p>8 Q. That's your opinion?</p> <p>9 MS. SCOTT: Objection.</p> <p>10 A. With respect to only my -- so I think 11 some of our confusion is is I'm talking about minerals 12 in general, so things, you know, you would see in a 13 museum. And then there's, essentially, the microscopic 14 scale.</p> <p>15 BY MR. FROST:</p> <p>16 Q. Okay. So there's a -- how you define 17 asbestiform is different depending on whether or not 18 it's a hand sample versus something you look at in a 19 microscope?</p> <p>20 A. Potentially, and things can, you know, 21 appear to be asbestiform, but they are pseudomorphs.</p> <p>22 Q. Okay. So other than size, which we've 23 now determined is aspect ratio, you can't tell me any 24 other properties that you would look at to determine 25 whether or not a particle, an elongated mineral</p>

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<p>1 particle, is a cleavage fragment versus an asbestiform 2 fragment. Is that -- is that a fair summary of your 3 opinion?</p> <p>4 A. I'm unsure. I'm sorry. I'm tired.</p> <p>5 The -- if it -- so the -- so in your question, mineral 6 type doesn't matter, correct?</p> <p>7 Q. I don't know. I'm asking you how you 8 define. Does mineral type matter for asbestiform versus 9 non-asbestiform?</p> <p>10 A. Well, there are minerals that tend to be 11 asbestiform or can be asbestiform and not. So, but 12 that's not necessarily related to the -- asbestiform is 13 a descriptor of the minerals, not necessarily -- so I 14 would use what, what I have in the report, basically. I 15 would say that a cleavage fragment can be an asbestiform 16 particle and size. The aspect ratio is a major 17 contributor.</p> <p>18 Also, the -- you know, if it is a -- so, 19 for example, if the chemistry and the electron 20 diffraction data and the images also indicate that it is 21 a mineral that is known to be asbestos, I think that 22 that would be -- that would support that.</p> <p>23 I think that, you know, if you had -- 24 it's like kyanite, for example, might -- kyanite might 25 have -- meet those dimension, fiber-dimension</p>	<p>1 first, it has to be of a rock that could be asbestiform, 2 and then the major component is the size, meaning aspect 3 ratio. Is that a fair summary of the definition you're 4 giving me?</p> <p>5 A. I'm not sure. I'm sorry. I'm spacing 6 out a little bit. A cleavage fragment can be 7 asbestiform.</p> <p>8 Q. Okay. But what I keep asking you is --</p> <p>9 A. The criteria?</p> <p>10 Q. The criteria you're using to define 11 something as asbestiform, is it purely rock type, that 12 is, a type of rock that can be asbestiform?</p> <p>13 A. I --</p> <p>14 Q. Hold on. That's one.</p> <p>15 A. Okay.</p> <p>16 Q. And then the other, which is the major 17 component, is the size, meaning the aspect ratio of the 18 particle. Are those the two things you look at when 19 you're determining whether or not a particle is an 20 asbestiform fiber?</p> <p>21 A. I would sort of correct myself in saying 22 the particle size and the mineralogy.</p> <p>23 Q. Okay. Particle size and mineralogy. And 24 mineralogy, meaning the type of mineral it is, correct?</p> <p>25 A. Yes.</p>
Page 103	Page 105
<p>1 requirements, but because it is kyanite, it wouldn't 2 necessarily be described as asbestiform, but it would be 3 a fiber. So there's complexities.</p> <p>4 Q. Okay. So I think we have -- I'll change 5 my summary of your opinion. So in determining whether 6 or not an elongated mineral particle, and we can agree 7 an elongated mineral particle is a particle that, you 8 know, broke off of something that's long, right? Can we 9 agree on that?</p> <p>10 A. Yes.</p> <p>11 Q. Okay. So in order to determine if an 12 elongated mineral particle is a cleavage fragment or 13 asbestiform fiber, the two things you look at are, 14 first, whether or not it's a rock that can be 15 asbestiform, and then, second, which is the major 16 component, is its size, meaning aspect ratio. Is that a 17 fair summary of your opinion?</p> <p>18 A. Well, so that's a different question. So 19 elongated mineral particle --</p> <p>20 Q. Then if elongated mineral particle's 21 confusing you, I'll take that out.</p> <p>22 So if we're trying to figure out if a 23 particle -- I don't care what size, I don't care if it's 24 elongated or not. If we're trying to figure out if a 25 particle is a cleavage fragment or an asbestiform fiber,</p>	<p>1 Q. Okay. And, again, the basis of your 2 opinion that that's the definition of asbestiform comes 3 from your coursework and undergraduate and graduate, 4 correct?</p> <p>5 A. Yes.</p> <p>6 Q. And sitting here today, you can't cite me 7 a single study in the peer-reviewed literature or from 8 any government organization that supports that theory, 9 correct?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 MS. O'DELL: Objection. Form.</p> <p>12 A. So --</p> <p>13 BY MR. FROST:</p> <p>14 Q. I'm just asking for citations.</p> <p>15 MR. LAPINSKI: Let him finish.</p> <p>16 A. I cannot -- I cannot -- let me think how 17 to phrase this. Peer review, I have had discussions, 18 actually, with my -- a former committee member, Bill 19 Mull. He was on my Ph.D. committee, and we had several 20 discussions about impurities and things like that and 21 industrial minerals. He was an industry guy.</p> <p>22 And, basically, we talked about small 23 particles breaking off and how that could be of concern 24 in different ways. And then I've had discussions in 25 industry about, essentially, fine particles getting</p>

<p style="text-align: right;">Page 106</p> <p>1 entrained in things with another company, one based here 2 in Cincinnati, not basically asbestiform, not basically 3 asbestos, but there's graphite and biotite. 4 So no peer-review literature, but I've 5 had discussions in a general sense, but not specific to 6 talc, but with contaminants, small particles breaking. 7 Q. So the basis -- 8 A. So I think companies sometimes use 9 different -- it's actually common for companies to use 10 different words. They have internal vocabularies, even, 11 you know, so that might be the issue. 12 BY MR. FROST: 13 Q. So it's based off your coursework and 14 discussions with industry individuals but not any 15 peer-reviewed literature? 16 MS. SCOTT: Objection. 17 A. Yes. Correct. 18 BY MR. FROST: 19 Q. All right. We're going to move to 20 another definition. Okay? 21 A. Okay. 22 Q. I note in your report -- let me find 23 where it is. At the top, under the section that says 24 "Asbestos" on page 4. Second sentence, you say, 25 "Asbestos is a naturally occurring mineral that can be</p>	<p style="text-align: right;">Page 108</p> <p>1 definition, according to the paragraph? 2 A. I'm just saying that's what they define 3 those as. 4 Q. Do you believe you've included the whole 5 definition that ATSDR has of asbestos in your paper? 6 MS. SCOTT: Objection. 7 A. I believe it's consistent with a document 8 I've done. I was gonna say, there are other academic 9 classifications. Sometimes I know, in my classwork, it 10 was discussed like antigorite sometimes comes up. 11 Antigorite is actually something that's detected in some 12 of the documents as well. So antigorite can be, look 13 like it's asbestos, but it's not officially classified. 14 So there's some con -- if you look in the 15 older literature, there's some confusion. People will 16 also refer to other minerals, perhaps incorrectly, as 17 being asbestos. So it's -- historically, I think it can 18 be a term that is applied either too loosely or things 19 just haven't worked out, so... 20 BY MR. FROST: 21 Q. And the definition of asbestos in the 22 ATSDR, is that something you found yourself or was that 23 given to you by plaintiffs' counsel? 24 MS. SCOTT: Objection. 25 A. I looked at -- ATSDR is something that</p>
<p style="text-align: right;">Page 107</p> <p>1 in close proximity to talc in mines around the world." 2 Is asbestos a mineral? 3 A. I'm sorry. It should be mineral group. 4 Q. Okay. That was going to be my next 5 question. Asbestos is a defined group of minerals, 6 correct? 7 A. Yeah. It can be referred to that. 8 Q. Okay. Without looking at your report, 9 can you tell me what minerals fit the definition of 10 asbestos? 11 MS. SCOTT: Objection. 12 A. Tremolite, crocidolite, anthophyllite, 13 chrysotile, amosite. 14 BY MR. FROST: 15 Q. And in your report, you know, you list 16 them. I believe it's here on page 4. You list the 17 amphibole class includes, you know, amosite, 18 crocidolite, actinolite, anthophyllite and tremolite, 19 correct? 20 A. I'm sorry. Where? 21 MS. SCOTT: Here. 22 BY MR. FROST: 23 Q. Page 4. 24 A. Yeah. So, yeah, end of the second line. 25 Q. And you're relying on the ATSDR for this</p>	<p style="text-align: right;">Page 109</p> <p>1 I've used in the past for my publications in general, so 2 I'm familiar with them. So we use that in a variety of 3 ways to help frame our discussions in peer-review 4 articles and things like that. 5 BY MR. FROST: 6 Q. All right. I'm going to mark this next 7 exhibit. I think we're on six. 8 MS. SCOTT: Yes. 9 MR. FROST: Yep. 10 (Exhibit 6 was marked for 11 identification.) 12 MR. FROST: Do you need a copy? 13 MR. FERGUSON: I'll take it unless 14 anybody else wants one. 15 MS. O'DELL: Have you directed us to a 16 page? 17 MR. FROST: He was looking at his 18 references to make sure. I think he's 19 identifying that it's the same article. 20 A. I'm not -- I'm not sure if this is Item 21 Number 6. 22 BY MR. FROST: 23 Q. Well, here. I can speed this up. You 24 agree with me that this is an ATSD article, correct? 25 A. Yes.</p>

<p style="text-align: right;">Page 110</p> <p>1 Q. Okay. Turn to -- actually, it's page 1.</p> <p>2 It's a misnomer. It's decently into it, probably about</p> <p>3 10 or 15 pages into it. As I said, the one is a</p> <p>4 misnomer. Okay.</p> <p>5 MS. SCOTT: I have a --</p> <p>6 MR. FROST: Yeah. I was going to say, I</p> <p>7 apologize for it being highlighted, but I'm</p> <p>8 going to read the highlighted parts anyway, so</p> <p>9 it will help guide us there. That was a</p> <p>10 printing issue.</p> <p>11 BY MR. FROST:</p> <p>12 Q. Do you see where it defines, under</p> <p>13 Section 1.1, "What is Asbestos"?</p> <p>14 A. Yes, I do.</p> <p>15 Q. Do you notice that its definition of</p> <p>16 asbestos are "the fibrous varieties of tremolite,</p> <p>17 actinolite and anthophyllite that occur naturally in the</p> <p>18 environment"?</p> <p>19 MS. SCOTT: Objection.</p> <p>20 A. I see that, yeah.</p> <p>21 BY MR. FROST:</p> <p>22 Q. That's slightly different than what you</p> <p>23 attribute the definition of asbestos from the ATSDR in</p> <p>24 your report, right? You don't note that it's the</p> <p>25 fibrous varieties of the amosite, crocidolite,</p>	<p style="text-align: right;">Page 112</p> <p>1 statement.</p> <p>2 MR. FROST: Sure.</p> <p>3 MS. SCOTT: Go ahead.</p> <p>4 BY MR. FROST:</p> <p>5 Q. Do you see the second highlighted portion</p> <p>6 on that page? It starts at the bottom. "Asbestos</p> <p>7 minerals consist of thin, separable fibers that have a</p> <p>8 parallel arrangement. Nonfibrous forms of tremolite,</p> <p>9 actinolite and anthophyllite are found naturally.</p> <p>10 However, because they are not fibrous, they are not</p> <p>11 classified as an asbestos mineral." That's different</p> <p>12 than what you're telling us here, correct?</p> <p>13 A. Let me compare.</p> <p>14 Q. Well, that's what you just told us, that</p> <p>15 you could have nonfibrous tremolite and it would still</p> <p>16 be asbestos.</p> <p>17 A. I'm sorry. What was the question again?</p> <p>18 This is not consistent with what I have written?</p> <p>19 Q. I'm saying it's not consistent with what</p> <p>20 you just told me. You just told me the fibers doesn't</p> <p>21 really matter because you can have --</p> <p>22 A. Fibers --</p> <p>23 Q. So my question is: You're relying on --</p> <p>24 say you rely on the ATSDR as the definition for</p> <p>25 asbestos, but your definition of asbestos, sitting here</p>
<p style="text-align: right;">Page 111</p> <p>1 actinolite, anthophyllite and tremolite, correct?</p> <p>2 A. Let me just double-check.</p> <p>3 Q. It's page 4.</p> <p>4 A. In two general classes. I omitted the</p> <p>5 word "fibrous," but it seems that the minerals are</p> <p>6 consistent.</p> <p>7 Q. Yeah, the minerals are consistent, but</p> <p>8 isn't the omission of "fibrous" an important distinction</p> <p>9 in the definition of what's asbestos and what isn't?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. In the context of this situation, I</p> <p>12 don't -- I don't think it exclusively applies because</p> <p>13 you can mechanically produce particles that are -- meet</p> <p>14 the criteria on the bottom of the last paragraph on page</p> <p>15 4. So tremolite -- and actually, you know, on one hand,</p> <p>16 IARC 2012 lists tremolite as a carcinogen in general.</p> <p>17 So IARC is not -- I was consistent, but you're correct.</p> <p>18 I did not use the word "fibrous."</p> <p>19 BY MR. FROST:</p> <p>20 Q. So you're not consistent, because you're</p> <p>21 saying ATSDR defines asbestos, and then you need to put</p> <p>22 them out. But you fail to leave out that these are</p> <p>23 fibrous. I'll tell you why it's important. Do you see</p> <p>24 the second highlighted portion?</p> <p>25 MS. SCOTT: Let me just object to the</p>	<p style="text-align: right;">Page 113</p> <p>1 today, is actually different than that of the ATSDR. So</p> <p>2 it doesn't really support what you're saying today,</p> <p>3 correct?</p> <p>4 MS. SCOTT: Objection. Misrepresents.</p> <p>5 A. No. I think that is a misrepresentation.</p> <p>6 So I cited this, and the minerals are listed here are</p> <p>7 the same minerals there.</p> <p>8 BY MR. FROST:</p> <p>9 Q. Okay.</p> <p>10 A. And then, based on my academic</p> <p>11 experience, knowledge, these minerals are also, you</p> <p>12 know, what I would list as well.</p> <p>13 Q. But that's not -- you didn't say they say</p> <p>14 that certain types of these minerals can be asbestos.</p> <p>15 The definition that you attribute, and you're talking</p> <p>16 today about asbestos, is different than the -- you say</p> <p>17 the ATSDR supports your definition of asbestos, but</p> <p>18 yours is actually slightly different than theirs, right?</p> <p>19 MS. SCOTT: Objection. Misrepresents.</p> <p>20 A. I left out a word.</p> <p>21 BY MR. FROST:</p> <p>22 Q. And according to them, it's an important</p> <p>23 word, because as the ATSDR says, "Because they are not</p> <p>24 fibrous, they are not classified as asbestos minerals."</p> <p>25 Do you agree?</p>

<p style="text-align: right;">Page 114</p> <p>1 MS. SCOTT: Objection.</p> <p>2 A. That's what's stated in the document.</p> <p>3 BY MR. FROST:</p> <p>4 Q. Okay. Let's move down to the third</p> <p>5 paragraph under "Asbestos" in your report. Do you see</p> <p>6 the -- I don't know. What sentence is it? Third</p> <p>7 sentence starts, "However, non-asbestiform cleavage</p> <p>8 particles can correspond to the definition of respirable</p> <p>9 fiber as defined by WHO and, due to its morphology, can</p> <p>10 have potentially dangerous health effects." Do you see</p> <p>11 that?</p> <p>12 A. Yes.</p> <p>13 Q. Now, you don't have an opinion yourself</p> <p>14 as to whether or not asbestiform can cause any disease.</p> <p>15 You're not a doctor, right?</p> <p>16 A. Correct.</p> <p>17 Q. And you're relying on, you know, other</p> <p>18 documents and things you've read for that statement?</p> <p>19 That's correct?</p> <p>20 A. Correct.</p> <p>21 Q. Do you have any opinion on whether or not</p> <p>22 the surface chemistries of cleavage fragments versus</p> <p>23 asbestiform fibers are the same?</p> <p>24 A. I'm not a surface geochemist.</p> <p>25 Q. Okay. Do you agree with me that IARC has</p>	<p style="text-align: right;">Page 116</p> <p>1 morphology can have potentially dangerous health</p> <p>2 effects?</p> <p>3 A. Yes, I say those documents.</p> <p>4 Q. Okay. Let's look at the NIOSH road map.</p> <p>5 MR. FROST: Did you mark that yet?</p> <p>6 (Exhibit 7 was marked for</p> <p>7 identification.)</p> <p>8 BY MR. FROST:</p> <p>9 Q. Do you recognize this as the NIOSH</p> <p>10 document that you were relying on for your statement?</p> <p>11 MS. SCOTT: Jack, can you, just for my</p> <p>12 ease, can you direct me to the citation within</p> <p>13 the report?</p> <p>14 MR. FROST: That I'm going to go to?</p> <p>15 MS. SCOTT: Yeah.</p> <p>16 MR. FROST: I'm going to page 5, or V,</p> <p>17 which is the Executive Summary.</p> <p>18 MS. O'DELL: Thank you. You're talking</p> <p>19 about in the NIOSH document?</p> <p>20 MR. FROST: Oh, in his?</p> <p>21 MS. O'DELL: Yes.</p> <p>22 MR. FROST: It's on page 4, third</p> <p>23 paragraph down from Asbestos. It's NIOSH 2010,</p> <p>24 IRSST 2012.</p> <p>25 MS. SCOTT: Thank you.</p>
<p style="text-align: right;">Page 115</p> <p>1 ultimately determined that non-asbestiform cleavage</p> <p>2 fragments actually are not or do not -- sorry. Let me</p> <p>3 reform that.</p> <p>4 Could we also agree that IARC has</p> <p>5 determined that non-asbestiform minerals are not</p> <p>6 carcinogenic?</p> <p>7 MS. SCOTT: Objection.</p> <p>8 A. I believe IARC 2012 lists tremolite as a</p> <p>9 carcinogen.</p> <p>10 BY MR. FROST:</p> <p>11 Q. And do you know what level of carcinogen?</p> <p>12 Do you know what category?</p> <p>13 MS. O'DELL: Objection to form.</p> <p>14 A. I don't specifically remember. I know</p> <p>15 there are three categories that are relevant. There's</p> <p>16 Group 1, and then Group 2-A and 2-B. Group 1 are known</p> <p>17 carcinogens. 2-A is probable, and I think 2-B is</p> <p>18 possible. But, again, I'm kind of --</p> <p>19 BY MR. FROST:</p> <p>20 Q. That's not your -- that's not your field</p> <p>21 of expertise?</p> <p>22 A. That's not my area.</p> <p>23 Q. And you also -- so you cite the NIOSH</p> <p>24 2010. You also cite the IRSST 2012, correct, for your</p> <p>25 proposition that these, the fragments of the same</p>	<p style="text-align: right;">Page 117</p> <p>1 A. I'm not seeing it in my list.</p> <p>2 BY MR. FROST:</p> <p>3 Q. Well, yeah. But if you look at page 4 of</p> <p>4 your report, you cite to NIOSH 2012 for the proposition</p> <p>5 that --</p> <p>6 A. Wait. Okay.</p> <p>7 Q. -- non-asbestiform cleavage fragments can</p> <p>8 have the same potentially dangerous health effects. If</p> <p>9 you turn to page V, "Executive Summary."</p> <p>10 A. Page V. Okay. "Executive Summary."</p> <p>11 Q. The second paragraph, about halfway down,</p> <p>12 there's a sentence that starts, "Asbestos fibers are</p> <p>13 clearly a substantial health concern."</p> <p>14 A. Let me find it. Okay. I found it.</p> <p>15 Q. After that, it reads, "Further research</p> <p>16 is needed to better understand health risks associated</p> <p>17 with exposure to other thoracic-size EMPs, including</p> <p>18 those with mineralogical compositions identical or</p> <p>19 similar to the asbestos minerals in those that have</p> <p>20 already been documented to cause asbestos-like disease</p> <p>21 as well as the physiochemical characteristics that</p> <p>22 determine their toxicity." Did I read that correctly or</p> <p>23 close enough, anyway, I'm sure?</p> <p>24 A. Yes, yes. Yep.</p> <p>25 Q. Okay. So, again, NIOSH here isn't saying</p>

<p style="text-align: right;">Page 118</p> <p>1 that -- NIOSH is not supporting the position you have in</p> <p>2 your paper here, correct? NIOSH's determination is that</p> <p>3 they can't make one. More research is necessary, right?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. That is what's stated here.</p> <p>6 BY MR. FROST:</p> <p>7 Q. Let's turn back to the IRSST document. I</p> <p>8 forget what we marked that as. I think it's 4. There</p> <p>9 it is. If you can turn to page 37.</p> <p>10 A. Okay.</p> <p>11 Q. And, again, at the top nine</p> <p>12 recommendations, it states, Since a conclusion cannot be</p> <p>13 reached about the biological effects from the</p> <p>14 distinction between a cleavage fragment and asbestos</p> <p>15 fibers -- actually, I did not read that correctly. Let</p> <p>16 me try again.</p> <p>17 "Since a conclusion cannot be reached</p> <p>18 about the biological effects from the distinction</p> <p>19 between cleavage fragments and asbestos fibers," and</p> <p>20 then it continues to say precautionary things. So,</p> <p>21 again, they also haven't determined, as you state in</p> <p>22 your report, that it has the same dangerous health</p> <p>23 effects, correct?</p> <p>24 MS. SCOTT: Objection. Scope.</p> <p>25 A. It says what it says.</p>	<p style="text-align: right;">Page 120</p> <p>1 indicated, I thought there might be typos in the report.</p> <p>2 Q. Okay. What's the typo?</p> <p>3 A. So, essentially, the difference should be</p> <p>4 diversity. Talc forms in the earth in metamorphic</p> <p>5 terranes, and the diversity is metamorphosed mafic and</p> <p>6 ultramafic rock deposits show the complexity of talc</p> <p>7 ores at different levels.</p> <p>8 Q. Okay. And --</p> <p>9 A. Sorry about that.</p> <p>10 Q. That's okay. Typos happens.</p> <p>11 Your support for that is Berg 1977?</p> <p>12 A. Yes.</p> <p>13 Q. I'll mark Berg.</p> <p>14 A. It's e.g., Berg, so that's an example.</p> <p>15 Q. Yes. Well, look at the one example you</p> <p>16 pointed to.</p> <p>17 MR. FROST: Let me see if I can find a</p> <p>18 copy. Let me see if I can find a copy where the</p> <p>19 staple hasn't come out. We'll mark that one.</p> <p>20 Do you all need one?</p> <p>21 MS. SCOTT: Sure.</p> <p>22 MR. FROST: Be careful of the staple.</p> <p>23 It's pokey.</p> <p>24 MS. SCOTT: I appreciate that.</p> <p>25 (Exhibit 8 was marked for</p>
<p style="text-align: right;">Page 119</p> <p>1 BY MR. FROST:</p> <p>2 Q. Yes. They come to the same conclusion as</p> <p>3 NIOSH, and that's, we don't know one way or the other.</p> <p>4 More research needs to be done, right?</p> <p>5 A. Correct.</p> <p>6 Q. Other than these two, can you point me</p> <p>7 right now to any other studies that actually support the</p> <p>8 sentence you have here in your report that cleavage</p> <p>9 fragments are the same, have the same dangerous health</p> <p>10 effects as asbestiform fibers?</p> <p>11 A. No.</p> <p>12 Q. All right. If we move down, further down</p> <p>13 to page 4 of your report, the section called "Formation</p> <p>14 of Talc deposits and inherent asbestos impurities."</p> <p>15 A. Okay.</p> <p>16 Q. The first sentence, "Talc forms in the</p> <p>17 earth in metamorphic terranes, and the difference is</p> <p>18 metamorphosed" -- I apologize. Can tell me how to</p> <p>19 pronounce that word?</p> <p>20 A. Metamorphosed.</p> <p>21 Q. Metamorphosed. Okay. "And the</p> <p>22 difference in metamorphosed mafic and ultramafic rock</p> <p>23 deposits show the complexity of talc ores at different</p> <p>24 levels."</p> <p>25 A. I'm sorry. That's a typo. As I</p>	<p style="text-align: right;">Page 121</p> <p>1 identification.)</p> <p>2 BY MR. FROST:</p> <p>3 Q. Do we agree this is the Berg '77 you</p> <p>4 reference in your report?</p> <p>5 A. I'm not a hundred percent sure.</p> <p>6 Q. It also appears, if you look at 18 --</p> <p>7 MS. O'DELL: Excuse me, Doctor. Are you</p> <p>8 finished? Did you finish with your answer?</p> <p>9 A. I'm not sure. So either I might have</p> <p>10 misquoted something. Let's see. I don't think I -- I</p> <p>11 don't think I have it. Let me --</p> <p>12 BY MR. FROST:</p> <p>13 Q. We can look at it during a break. We can</p> <p>14 come back.</p> <p>15 A. I'll check. Berg had several.</p> <p>16 Q. I believe it's number 18.</p> <p>17 A. So I am not a hundred percent sure. I</p> <p>18 might have misquoted --</p> <p>19 Q. Okay.</p> <p>20 A. -- this. Because, as I remember the</p> <p>21 book, it was -- I honestly don't think I --</p> <p>22 Q. Looked different?</p> <p>23 A. Yeah. It was -- yeah. I think I've</p> <p>24 looked at some of this before. It looks familiar, but</p> <p>25 the thing that I'm thinking, I think I misquoted. I'm</p>

<p style="text-align: right;">Page 122</p> <p>1 sorry.</p> <p>2 Q. If I were to tell you that talc isn't</p> <p>3 even mentioned in this paper --</p> <p>4 A. Yeah. I mean, there's like -- the book I</p> <p>5 had, there's images of mines that talks about, I think,</p> <p>6 the Yellowstone mines, specifically. So I'm sorry about</p> <p>7 that. I totally, totally missed that.</p> <p>8 Q. Okay. If we move down to the next</p> <p>9 sentence, you state that "Italian mines, which Johnson &</p> <p>10 Johnson and Imerys obtained talc for cosmetic</p> <p>11 production, were ultramafic origin."</p> <p>12 A. Okay.</p> <p>13 Q. Is that true?</p> <p>14 A. I believe so.</p> <p>15 Q. Can we turn back to the IARC 2010? It's</p> <p>16 the one with the orange cover. Go to page 283 to 84.</p> <p>17 A. Okay.</p> <p>18 Q. If you look at B, towards the bottom, it</p> <p>19 says, "Talc derived from magnesium carbonites."</p> <p>20 A. Okay.</p> <p>21 Q. "Talc deposits formed from the alteration</p> <p>22 of carbonite and sandy carbonite, such as dolomite and</p> <p>23 limestone, are the most important in terms of world</p> <p>24 production. Two types are recognized." And if you skip</p> <p>25 down to two, it says, "Those derived from hydrothermal</p>	<p style="text-align: right;">Page 124</p> <p>1 think --</p> <p>2 Q. You certainly didn't include it in the</p> <p>3 report, right?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. I don't know. I forget.</p> <p>6 THE WITNESS: Can we take a break?</p> <p>7 MR. FROST: Sure.</p> <p>8 VIDEOGRAPHER: We're now going off</p> <p>9 record. The time is 12:21.</p> <p>10 (A recess was taken from 12:21 to 1:25.)</p> <p>11 VIDEOGRAPHER: We're now back on record.</p> <p>12 The time is 1:25.</p> <p>13 BY MR. FROST:</p> <p>14 Q. All right. Welcome back from lunch. We</p> <p>15 were on page 4 of your report under "Formations of</p> <p>16 Talc." And we talked about Italy. Let's move on to</p> <p>17 Vermont. You say, "Vermont mines relevant to this</p> <p>18 litigation are mafic and ultramafic origins." What's</p> <p>19 your support for that statement?</p> <p>20 A. I'm sorry. Oh, bottom of 4?</p> <p>21 Q. Yeah, bottom of 4, moving on to 5.</p> <p>22 A. It's the geology of the area.</p> <p>23 Q. Do you believe there are mafic formations</p> <p>24 of talc relevant to the Vermont mines used by Johnson &</p> <p>25 Johnson and Imerys in this case?</p>
<p style="text-align: right;">Page 123</p> <p>1 alteration (including retrograde metamorphism) of</p> <p>2 regionally *metamorphosed siliceous dolomites and other</p> <p>3 magnesium-rich rocks." And then if you turn the page</p> <p>4 over one, two, three, it says "Italy vouches own after</p> <p>5 that."</p> <p>6 A. So this is information produced by</p> <p>7 Luzenac?</p> <p>8 Q. Well, this is from IARC.</p> <p>9 A. It's in IARC, but they're citing Luzenac</p> <p>10 as part of this, and each -- the occurrences of each</p> <p>11 individual mine are -- location are not shown. IARC is</p> <p>12 more of a health thing. I would not necessarily expect</p> <p>13 a detailed analysis of a geology from an IARC monograph.</p> <p>14 So...</p> <p>15 Q. Can you point to me to any geological</p> <p>16 study that shows --</p> <p>17 MR. LAPINSKI: Counsel, let him finish</p> <p>18 his answer first.</p> <p>19 A. So, I don't think that -- I don't know</p> <p>20 what they are specifically relying on.</p> <p>21 BY MR. FROST:</p> <p>22 Q. Can you cite me any geological study that</p> <p>23 shows that the Italian mines of Val Chisone were of</p> <p>24 ultramafic origin?</p> <p>25 A. I forget the citations specifically. I</p>	<p style="text-align: right;">Page 125</p> <p>1 A. Yes.</p> <p>2 Q. And do you have a geological survey or</p> <p>3 something else you're relying on for that?</p> <p>4 A. There are USGS reports and things like</p> <p>5 that.</p> <p>6 Q. And they say mafic? They don't just say</p> <p>7 it's an ultramafic belt?</p> <p>8 A. I believe so.</p> <p>9 Q. On page 5, kick down to the next</p> <p>10 paragraph, the one that starts, "Asbestos minerals,</p> <p>11 including chrysotile, tremolite and actinolite" -- I'm</p> <p>12 sorry, "tremolite, actinolite and anthophyllite are</p> <p>13 common in talc ores." What's your basis for the</p> <p>14 statement, because it's uncited?</p> <p>15 A. It's common knowledge --</p> <p>16 Q. Can you point me to a --</p> <p>17 A. -- mineralogy.</p> <p>18 Q. Can you point me to a peer-reviewed</p> <p>19 source that states that?</p> <p>20 A. Let see here.</p> <p>21 MR. LAPINSKI: Jack, while he's looking,</p> <p>22 what was the statement from the report?</p> <p>23 MR. FROST: It's page 5, the first</p> <p>24 sentence of the first full paragraph. The</p> <p>25 "Asbestos minerals, including chrysotile,</p>

<p style="text-align: right;">Page 126</p> <p>1 tremolite," et cetera. The first full 2 paragraph. 3 A. So reference 40, figure 3, is a 4 comparison I computed with silica activities. So, 5 essentially, it showed boundaries between talc and 6 chrysotile. And figure 2 shows temperature pressure 7 diagrams for chrysotile and talc. Figure 4 shows 8 comparison of computer phase equilibrium, experimental 9 data of Johannes, 1969. It shows chrysotile and talc 10 fields. So the significance of those fields is that 11 because of -- so those are fields where things, when, in 12 absolute equilibrium, those discrete phases are set or, 13 essentially, those are the phases that are stable. 14 The minerals are stable. But you can go 15 back, you know, because of geologic conditions are 16 variable, you can have metamorphism that heats up an 17 area or then cools down. You can then -- the geologic 18 conditions then can cross those phase boundaries, and 19 you essentially can have minerals that are stable for a 20 while and then revert. But, often, those reversions are 21 not necessarily complete. And to substantiate that -- 22 BY MR. FROST: 23 Q. Can I stop you right there? 24 A. Yes. 25 Q. Where does Chernoskey say that asbestos</p>	<p style="text-align: right;">Page 128</p> <p>1 something. That's not actually stated in this book, 2 correct? 3 MS. SCOTT: Object to the form. 4 A. The diagrams are -- that's how one can 5 interpret these diagrams. 6 BY MR. FROST: 7 Q. Okay. So -- 8 A. The field -- 9 Q. Does it say it's common? 10 MR. LAPINSKI: Counsel, let him finish 11 his answer, please. 12 MR. FROST: Sure. 13 A. So, you know, phase diagrams and the 14 interpretation of phase diagrams is something that 15 mineralogists and petrologists do all the time, and 16 basically, we often will refer to a given phase diagram. 17 People spend their entire lives perfecting phase 18 diagrams. That was typically in the '50s, '60, '70s and 19 '80s. 20 So people will actually refer to specific 21 phase diagrams by people. So one of my committee 22 members, when I was on my Ph.D., he had the best phase 23 diagram for quartz for some period of time. So we use 24 those phase diagrams. They're commonly used to 25 interpret mineral associations and assemblages.</p>
<p style="text-align: right;">Page 127</p> <p>1 minerals are common in talc ores? You just told me 2 about how, chemically, things form -- 3 A. The thermodynamic diagram. I'm sorry. 4 Go ahead. 5 Q. Yes. You just told me about how 6 chemically talc forms, but where does Chernoskey talk 7 about talc ores and relate that asbestos minerals are 8 common in talc ores? 9 A. So this is a mineralogical volume, so 10 this is a review volume, and basically, talc is a 11 mineral that is in talc ores and, therefore, is 12 relevant. 13 Q. So you're telling me how talc forms, and 14 where on the pressure and temperature scale, you know, 15 it can go back and forth to, you know, tremolite. But, 16 again, does that, just because something can form in 17 nature, where does it say that asbestos minerals are 18 common in talc ores? What you're telling me -- 19 A. Well, these are -- 20 Q. -- is scientifically how talc forms. 21 A. They're commonly associated 22 thermodynamically. 23 Q. And that says that in that book? 24 A. The diagrams indicate that. 25 Q. Okay. But this is you interpreting</p>	<p style="text-align: right;">Page 129</p> <p>1 To further answer the question, the -- I 2 believe it's the Veblen '79. Veblen and Buseck is the 3 science paper that shows the TEM associations, you know, 4 essentially, these intergrowths of talc and chrysotile. 5 And, essentially, that literature proves the -- 6 essentially, the interpretation of the assertion I said, 7 that you go between these regions that are of one 8 condition and another. You don't necessarily get the 9 full conversion because of the kinetics. Essentially, 10 either the reaction goes too fast or things basically 11 sort of get frozen in the rock, depending upon the 12 various conditions. 13 BY MR. FROST: 14 Q. Okay. So let's be careful with the 15 language we're using here. What you're giving me is a 16 generalization about how talc, the mineral, forms, and 17 what other minerals that might be associated with that 18 formation. Is that -- is that fair? 19 A. I would be hesitant about the word 20 "generalization." I mean, these are experiments. They 21 take years. 22 Q. Okay. But -- 23 A. And the data, you know, these boundaries, 24 people in the '50s, '60s and '70s, I mean, they put a 25 great deal of effort into establishing the boundaries.</p>

<p style="text-align: right;">Page 130</p> <p>1 These are relevant for understanding larger processes of 2 metamorphism and understanding, you know, what -- 3 essentially what the history of the earth is. So the 4 diagrams aren't generalized. They're very, very 5 specific -- 6 Q. That's why I want you to listen very 7 carefully to what I'm asking you. We'll really step 8 back. 9 All right. You agree with me, talc ore 10 is different than talc, right? Ore means it's the 11 deposit that is being mined, right? 12 MS. O'DELL: Objection. 13 A. The mineral talc is a primary -- 14 Q. But listen to the "ore." 15 A. -- constituent -- 16 MR. LAPINSKI: Let him answer the 17 question, Counsel. 18 A. So the mineral talc is a primary 19 constituent of ore, and you can't -- 20 BY MR. FROST: 21 Q. And that's why I want you to listen to 22 me. I'm talking about ore. Ore means it's a talc 23 deposit that's being mined, right? You wouldn't find a 24 piece of talc you found in somebody's backyard and call 25 it ore, would you? Ore is a definition of a mineral</p>	<p style="text-align: right;">Page 132</p> <p>1 MS. SCOTT: Objection. 2 A. You can have an ore of talc. The two are 3 not -- so go ahead. Proceed. 4 BY MR. FROST: 5 Q. So where in this book is it specifically 6 saying that talc ores, which are ores that have been, 7 you know, talc deposits that have been determined, as 8 you said, to be economically viable, will commonly be 9 associated with chrysotile, tremolite, actinolite, 10 anthophyllite? 11 MS. SCOTT: Objection. 12 A. The mineral constituency -- 13 BY MR. FROST: 14 Q. So, again, you're -- 15 A. -- is -- minerals make up the talc ore. 16 So you can't separate -- you can't separate the ore from 17 the mineral when you're talking about how it's formed. 18 It's integral. I mean, it's absolutely integral to the 19 ore. You know, it would not be an ore if it didn't have 20 talc in it, right? It wouldn't -- you have to have the 21 required constituent in order for it to be an ore. 22 So, therefore, you know, every 23 petrologist in the world, every, you know, mineralogist, 24 you know, we refer to these thermodynamic diagrams that 25 have been worked out for, you know, now, some of them,</p>
<p style="text-align: right;">Page 131</p> <p>1 that's being mined. Do you agree with me there? 2 MS. SCOTT: Objection. 3 A. Yeah. Ore is not necessarily a mineral. 4 Ore can be multiple minerals. 5 BY MR. FROST: 6 Q. Sure. But ore is something that's being 7 mined, right? 8 A. Yes. It's something of economic 9 interest -- 10 Q. Sure. So in order -- 11 A. -- as opposed to a primary material of 12 interest. 13 Q. Okay. So in order to be an ore, it has 14 to be something that's being mined, right? 15 MS. SCOTT: Objection. 16 A. No. You can have ores that are not being 17 mined. They're just recognized as ore deposits. I have 18 a book of ore deposits. 19 BY MR. FROST: 20 Q. Okay. It's not this complicated, sir. 21 Just listen to what I'm saying. Talc ore means 22 something different than just a talc, you know, deposit, 23 a talc formation somewhere. A talc ore is something 24 that has been identified as a mineable source of talc. 25 Are we fair on that?</p>	<p style="text-align: right;">Page 133</p> <p>1 you know, decades. One was '69 or whatever. So I don't 2 think it's -- it's my professional opinion that these 3 thermodynamic diagrams adequately relate and describe to 4 the mineral phases that occur in talc ore. 5 BY MR. FROST: 6 Q. Okay. So you are making a 7 generalization, based upon the mineral phases, that all 8 talc ores -- 9 A. I would be hesitant to call it a 10 generalization. I mean, it's -- 11 Q. Can I finish my question, sir? 12 A. Yeah. I'm sorry. Sorry. Go ahead. 13 Q. So, again, can you give me a -- can you 14 give me a cite that shows that anthophyllite is common 15 in every talc ore mined across the world? 16 MS. SCOTT: Objection. 17 A. Where does it say that in the report? 18 Q. "Asbestos minerals, including chrysotile, 19 tremolite and actinolite and anthophyllite are common in 20 talc ores." 21 A. Are common, yes. You said every talc 22 deposit in the world. 23 Q. Well, no. Show me where -- show me in 24 there where it says that anthophyllite is common in 25 every talc ore across the world.</p>

<p style="text-align: right;">Page 134</p> <p>1 A. I think the interpretations of these 2 thermodynamic diagrams indicate that it's -- 3 Q. So it's purely theoretical? 4 A. No. It's experimental. 5 Q. Okay. 6 A. Is how the diagrams are designed. And 7 then, essentially, these are peer-reviewed articles that 8 are long-standing. So let me just check that to be 9 sure. Yeah, so there's, you know, these different -- so 10 Berman '88 is kind of one of these benchmark 11 thermodynamic databases, and we use these all the time 12 to understand and predict mineral stabilities and 13 understand and interpret the environments. 14 So, essentially, through the use of these 15 diagrams over time, we can interpret, you know, the 16 condition. So whether it's an ore or talc, you know, is 17 immaterial, the thermodynamics don't, don't really care. 18 Q. Well, don't you agree with me that 19 depending on the temperature, time and pressure, the 20 constituent rock of any particular deposit is going to 21 be different? I mean, that's what those phase diagrams 22 say, right? 23 MS. SCOTT: Objection. 24 A. No. The phase diagrams indicate that 25 things will be stable under different fields.</p>	<p style="text-align: right;">Page 136</p> <p>1 I mean, this is long recognized. 2 BY MR. FROST: 3 Q. See, that's why -- I fear you're not 4 listening to my questions. My question is: Depending 5 upon the thermodynamics that were in play in creating 6 any particular deposit, it will be different. And 7 depending on the differences, you will get different 8 mineral crystallization within the phases, correct? 9 MS. SCOTT: Object to the form. 10 A. Each situation may be slightly different. 11 But the -- to the blunt of the major phases, the 12 thermodynamics is relevant, and actually, you can 13 tweak -- you know, there's other programs that exist. 14 So, for example, on the igneous field, 15 there's a program called MELTS where you can fine tune 16 your models. And I think things were being in 17 development for these. You know, essentially, similar 18 types of things exist. There's like geochemist 19 workbench and other modeling programs that exist. 20 So, yes, you can -- things will change, 21 but these diagrams are generalizable in the sense that 22 they can be applied to multiple regions throughout 23 the -- throughout the world. 24 BY MR. FROST: 25 Q. And that's exactly what I asked you at</p>
<p style="text-align: right;">Page 135</p> <p>1 BY MR. FROST: 2 Q. That's what I'm talking about. So you'll 3 have -- different minerals are stable under different 4 pressures and temperatures, right? 5 MS. SCOTT: Objection. 6 A. Not -- because of the kinetics, 7 essentially, this lag effect. You know, things are -- 8 that's not necessarily the case. So diamonds, you know, 9 the classic example that we use in courses, diamonds are 10 thermodynamically stable deep in the earth. They get 11 brought up and then they -- thermodynamically, they 12 should persist. But because of the kinetics in that 13 particular situation, the bonds of the carbon are 14 really, really strong. That diamond doesn't revert to 15 graphite. 16 So, essentially, the thermodynamics gives 17 us a guide. It is a very, very good guide. But when 18 things cross these boundaries, it takes time to 19 essentially equilibrate to the new conditions. And if 20 not enough time evolves geologically, things occur such 21 that you get these relic phases. And in the case of 22 talc ores or talc deposits or whatever you want to call 23 that, you can have essentially these relics or asbestos 24 minerals, chrysotile, for example, that co-occur. So 25 the thermodynamics basically is -- and people know that.</p>	<p style="text-align: right;">Page 137</p> <p>1 the very beginning is these are generalizable tables 2 that you can use to predict what's in a particular 3 deposit? 4 A. They're not tables. They're phase 5 diagrams. 6 Q. Or figures or phase diagrams. 7 A. Yeah. 8 Q. But so we're right back to where I 9 started, and that's these are generalization of how 10 phases work that you can use to predict what's in 11 something, but it's not necessarily saying there is this 12 constituent in this particular deposit, correct? 13 MS. SCOTT: Objection. 14 BY MR. FROST: 15 Q. How the phase operated will affect what's 16 in a particular deposit, right? 17 A. So it's really the combination of the 18 phase diagram. Plus, you know, I keep referring to 19 Veblen. 20 Q. Yeah. 21 A. So basically, yeah. So the phase diagram 22 is relevant when things are -- assumed to be absolutely 23 perfect when everything is in thermodynamic equilibrium. 24 Q. Yes. 25 A. And it is relevant when it's not. When</p>

<p style="text-align: right;">Page 138</p> <p>1 things are not or when they're moving, things</p> <p>2 essentially react and progress slowly. But you can have</p> <p>3 incomplete or imperfect reactions as, you know,</p> <p>4 illustrated by the one Buseck paper, the '79 paper.</p> <p>5 Q. So if you want to predict what's in a</p> <p>6 particular deposit, you have to sort of know what the</p> <p>7 time pressure, the metamorphic history of it, when it</p> <p>8 formed, how stable it was, what it started from, what</p> <p>9 the constituent beginning minerals were, you know. Then</p> <p>10 you can apply that to a phase model?</p> <p>11 A. If you want to predict -- I'm sorry.</p> <p>12 Q. Yeah. And then you can apply it to the</p> <p>13 phase model, right?</p> <p>14 A. No.</p> <p>15 MS. SCOTT: Objection.</p> <p>16 A. Well, There's multiple ways of predicting</p> <p>17 what a deposit would be, and it's scale dependent, phase</p> <p>18 dependent. It's dependent on the geology, and it's</p> <p>19 dependent upon tectonics, as well. So there's many</p> <p>20 things. So as a mineralogist, you know, one thing that</p> <p>21 I would heavily rely on are the phase diagrams.</p> <p>22 BY MR. FROST:</p> <p>23 Q. Sure. But you have to know the specific</p> <p>24 history of a formation if you want to do an accurate</p> <p>25 prediction of what's in that particular thing. The</p>	<p style="text-align: right;">Page 140</p> <p>1 BY MR. FROST:</p> <p>2 Q. Then you cite Evans 2004 as the basis for</p> <p>3 that statement?</p> <p>4 A. Yes.</p> <p>5 MR. FROST: Let's mark this.</p> <p>6 MR. LAPINSKI: What number is this?</p> <p>7 VIDEOGRAPHER: Nine.</p> <p>8 MR. FROST: I told you I'd forget.</p> <p>9 (Exhibit 9 was marked for</p> <p>10 identification.)</p> <p>11 BY MR. FROST:</p> <p>12 Q. Do you recognize this article?</p> <p>13 A. Yes, I do.</p> <p>14 Q. Can you point to me where this article</p> <p>15 shows that talc and chrysotile are associated with each</p> <p>16 other in deposits?</p> <p>17 A. The thing I was referring to is</p> <p>18 concluding remarks. "Despite an up temperature</p> <p>19 transition from lizardite to chrysotile at these</p> <p>20 temperatures, the latter remains metastable."</p> <p>21 So basically in giving these diagrams,</p> <p>22 the thermodynamic diagrams, because that metastability,</p> <p>23 that's the kinetic thing, that's what, essentially, the</p> <p>24 chrysotile would potentially persist.</p> <p>25 Q. Okay. So he's not saying that. You're</p>
<p style="text-align: right;">Page 139</p> <p>1 phase diagrams are one of the things you'd look at,</p> <p>2 right?</p> <p>3 MS. SCOTT: Objection.</p> <p>4 A. You would use phase diagrams to predict</p> <p>5 potential, potentially what would be in text, because</p> <p>6 you have this kinetic issue, right.</p> <p>7 BY MR. FROST:</p> <p>8 Q. Yeah, and that's based upon the geologic</p> <p>9 formation, all the other factors that come into how that</p> <p>10 formation was formed, temperature, pressure, time, you</p> <p>11 know, all the things that we've talked about, right?</p> <p>12 A. You can use the phase diagrams. Also if</p> <p>13 you have bulk chemistry data -- if you have bulk</p> <p>14 chemistry data, you can use that bulk chemistry data,</p> <p>15 sort of figure out and do models to see where things</p> <p>16 are. So you don't necessarily have to know -- so you</p> <p>17 can, you an model things, and that model would give you</p> <p>18 some prediction.</p> <p>19 Q. If you look at the next sentence, it</p> <p>20 says, "Talc and chrysotile are associated with each in</p> <p>21 talc deposits at the micrometer and nanometer scale</p> <p>22 making the separation impossible during the mining and</p> <p>23 manufacturing process." Do you see that?</p> <p>24 A. Yes.</p> <p>25</p>	<p style="text-align: right;">Page 141</p> <p>1 just interpreting that from this article? That's not</p> <p>2 his conclusion? That's yours?</p> <p>3 A. That is the interpretation of the</p> <p>4 thermodynamic, you know, this article. And I think that</p> <p>5 data supports it as does other, you know, these</p> <p>6 diagrams.</p> <p>7 Q. What I'm saying is that's not his.</p> <p>8 That's not Evans' conclusion. That's you interpreting</p> <p>9 data within the Evans report, correct?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. Yes, but I'm citing that.</p> <p>12 BY MR. FROST:</p> <p>13 Q. Okay. Let's move on. The next</p> <p>14 paragraph, the one that starts "Metamorphic systems." I</p> <p>15 believe it's the last sentence. It says, "Reactions can</p> <p>16 also progress for some period and then revert to</p> <p>17 asbestiform mineral chrysotile," and it continues</p> <p>18 because it changes.</p> <p>19 So, hopefully, you'll agree with me on</p> <p>20 this one. For it to revert back to chrysotile, it would</p> <p>21 have to have started as chrysotile, correct?</p> <p>22 A. So that is a possibility. You can go</p> <p>23 from -- that's what the stability fields are all about.</p> <p>24 So you can start off as chrysotile. You can cross that</p> <p>25 phase boundary, and then it can revert back if the</p>

<p style="text-align: right;">Page 142</p> <p>1 conditions change back. And, actually, we know this in 2 metamorphic rocks, that, essentially, the phase 3 assemblage can basically go back and forth, back and -- 4 it can revert. So I'm specifically -- I'm talking about 5 reverting on that phase boundary. 6 Q. Yes, but it can only revert back to 7 chrysotile if it started at chrysotile, right? 8 A. So that might be a poor phrasing of the 9 word, but essentially it's not an inaccurate phrasing. 10 So when I wrote this, I was thinking of these phase 11 diagrams. 12 Q. What I'm getting at is, let's say it 13 started as, you know, a serpentinite or an anthophyllite 14 converted to talc. It's not going to then revert back 15 to a different crystal, right? It's not going to -- 16 it's not going to go from anthophyllite to talc to 17 chrysotile? 18 A. Based on the geologic history, there's 19 multiple pathways. So it won't revert to the same magic 20 crystal, if that's what you're implying. 21 Q. So the way -- and I agree with you. It's 22 very inartfully written here. So you say, "Reactions 23 can progress for some period of time and then revert to 24 the mineral chrysotile." So the reactions of talc can 25 only revert back to chrysotile if that's where they</p>	<p style="text-align: right;">Page 144</p> <p>1 completely new chemical structure of chrysotile, 2 correct? 3 A. Correct. Not all the time, yeah. 4 Q. Okay. Thank you. Bear with me a second 5 here. Okay. Next paragraph down after you cite the 6 various Imerys documents, you said, "A 1977 thesis by 7 Barry Seymour (JNJ 272469) describes the complex 8 mineralogical development of the specific ore." So are 9 you talking about the specific ore in the Seymour paper 10 or are you talking about the specific ore at issue in 11 this case? 12 A. I forget. Can we bring that document up? 13 Q. Yeah, I can get you Seymour. 14 MR. FROST: Would you like a copy? 15 MS. SCOTT: Yes, please. Thank you. 16 (Exhibit 10 was marked for 17 identification.) 18 MS. SCOTT: Are you marking this? 19 MR. FROST: Yes, I forget what number it 20 is. 21 MS. SCOTT: Ten. 22 MR. FROST: Ten. 23 A. I think "specific" is -- I think it might 24 be a typo. 25</p>
<p style="text-align: right;">Page 143</p> <p>1 started from, correct? 2 MS. O'DELL: Objection to form. 3 A. So let me just read the sentence before 4 here, because I think -- "Reactions may also be 5 incomplete, meaning there may not be enough geologic 6 time or other chemical component to drive the reaction 7 to completion as discussed in Deer, Howie and Zussman. 8 Reactions can also progress for some period of time, 9 then revert to asbestiform mineral chrysotile because of 10 changes in geologic conditions." 11 So, in part, I think I'm referring to 12 Deer, Howie and Zussman. I don't think I've said 13 anything inaccurate there. It's not exclusive to -- 14 BY MR. FROST: 15 Q. I'm trying to clarify -- 16 A. You know, you can have reactions, you 17 know, that's not complete. 18 Q. So what I'm getting at, it's a really 19 simple question. The reversion won't always be from 20 talc to chrysotile, right? It will only revert back to 21 chrysotile if that's where it started. Do you agree 22 with me there? So while it may be correct that if it 23 starts as chrysotile, partially transforms to talc and 24 reverts back to chrysotile, that makes sense. But if it 25 starts as something else, it's not going to revert to a</p>	<p style="text-align: right;">Page 145</p> <p>1 BY MR. FROST: 2 Q. Okay. 3 A. So as I look at this document, I 4 basically remember looking at the introductory material 5 in it. So -- 6 Q. You'd agree with me it's a thesis about 7 the East Johnson mine? 8 A. I would have to reread the document. 9 Q. If I would represent to you it's about 10 the East Johnson mine and if you actually look at the 11 abstract -- 12 A. Foley and Johnson. 13 Q. And you'd also agree with me the East 14 Johnson mine was never one that was used for cosmetic 15 talcum powder by Johnson & Johnson, correct? 16 MS. O'DELL: Objection to form. 17 A. It may not have been used, but it is in 18 the same general geology. And, certainly, in geology, 19 it is part of the same general terrane, so therefore, 20 it's not exactly like the hammer, the Rainbow mine, but 21 it is relevant because it's geologically connected in 22 the sense of the terranes. 23 BY MR. FROST: 24 Q. So you're telling me that it has the same 25 formation as the deposits in the Hammondsville and</p>

<p style="text-align: right;">Page 146</p> <p>1 Rainbow mines or are you just saying --</p> <p>2 A. I don't remember specifically, but</p> <p>3 essentially the geology, so...</p> <p>4 Q. The second half of my question, or is it</p> <p>5 more that you're basing it on they're all part of the</p> <p>6 ultramafic belt, the Appalachian ultramafic belt that</p> <p>7 runs from Quebec through Georgia?</p> <p>8 A. It is more the general geologic</p> <p>9 association.</p> <p>10 Q. Okay. That's all I was going to ask</p> <p>11 about that.</p> <p>12 A. Page 15 is geologic map of Vermont. It</p> <p>13 shows things being connected.</p> <p>14 Q. Well, it shows the Appalachian ultramafic</p> <p>15 belt running through Vermont, correct?</p> <p>16 A. Yes.</p> <p>17 Q. Turn to page 6 of your report, the</p> <p>18 "Common toxic metals of interest." So before we start</p> <p>19 looking at any specific documents, will you agree with</p> <p>20 me that seeing metals at certain levels in deposit</p> <p>21 samples is different than seeing metals in certain</p> <p>22 levels in a finished talcum powder product?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. It can be metals in processing. It could</p> <p>25 be reduced or they could also be increased depending</p>	<p style="text-align: right;">Page 148</p> <p>1 define the geology as a whole, you know. So they want</p> <p>2 to know where ore is and where ore is not, if there is</p> <p>3 problematic areas. So, for example, the mine I work</p> <p>4 with in Nevada, they have a formation, Stebbins Hill</p> <p>5 unit that they avoid, because it's got all kinds of</p> <p>6 problematic stuff in it.</p> <p>7 Q. And that's probably a pretty good</p> <p>8 example. I take it they -- every now and again, they</p> <p>9 take samples from the problematic portion of that mine,</p> <p>10 correct?</p> <p>11 A. They sample everything as they go. So</p> <p>12 I've seen datasets of 20,000 from a single -- single</p> <p>13 level.</p> <p>14 Q. So what I'm getting to is just because</p> <p>15 you have a test of -- you know, a test coming back from</p> <p>16 a mine doesn't necessarily mean that the rock associated</p> <p>17 with that test makes it into the final product, right?</p> <p>18 MS. SCOTT: Objection.</p> <p>19 A. I don't -- there's no -- I didn't see any</p> <p>20 specific chain of custody, so I can't, you know.</p> <p>21 BY MR. FROST:</p> <p>22 Q. I'm talking from a general perspective.</p> <p>23 They're sampling a lot more of the rock than that</p> <p>24 ultimately ends up in a final product in a mine,</p> <p>25 correct?</p>
<p style="text-align: right;">Page 147</p> <p>1 upon the details of the processing. I don't think I saw</p> <p>2 any documents, although I requested documents, any</p> <p>3 documents about the detail, you know, before -- before</p> <p>4 and after, kind of full throughput, you know, as far as</p> <p>5 watching a specific sample go through, but, yeah.</p> <p>6 BY MR. FROST:</p> <p>7 Q. You'd also agree with me, too, that</p> <p>8 sometimes mine samples aren't necessarily from the ore</p> <p>9 that is used in the final product. It might be from a</p> <p>10 boundary. It might be from a surrounding rock, a black</p> <p>11 wall. Just because you see something in a sample</p> <p>12 doesn't necessarily mean that that's the ore that is</p> <p>13 then converted over into the final powder as well,</p> <p>14 correct?</p> <p>15 MS. SCOTT: Objection.</p> <p>16 MS. O'DELL: Object to form.</p> <p>17 A. I am confused by the question. As I</p> <p>18 think I understand you, can contaminants or other</p> <p>19 material that is not the primary ore be included in the</p> <p>20 ore processing?</p> <p>21 BY MR. FROST:</p> <p>22 Q. Other way around. When you sample a</p> <p>23 mine, when you drill sample holes, they're not just</p> <p>24 drilling the mineable ore body, correct?</p> <p>25 A. Generally correct. They're looking to</p>	<p style="text-align: right;">Page 149</p> <p>1 MS. SCOTT: Objection.</p> <p>2 A. So there's a difference between coring to</p> <p>3 define your geology and then mining --</p> <p>4 BY MR. FROST:</p> <p>5 Q. Uh-huh. That's what I'm saying.</p> <p>6 A. -- to get your product.</p> <p>7 Q. So just because you find something here</p> <p>8 doesn't necessarily mean that that ends up, that</p> <p>9 particular test sample ends up in the final ore that</p> <p>10 makes it to the grinding process for final talc,</p> <p>11 correct?</p> <p>12 MS. SCOTT: Objection. Speculation.</p> <p>13 A. Yeah. You don't -- that would be</p> <p>14 speculative or you -- it doesn't mean it doesn't.</p> <p>15 BY MR. FROST:</p> <p>16 Q. But, again, that's why --</p> <p>17 A. So --</p> <p>18 Q. Okay. I'll ask you this way. Does every</p> <p>19 single sample that's ever tested in a mine --</p> <p>20 MS. O'DELL: Excuse me. You guys just --</p> <p>21 MR. FROST: Sure.</p> <p>22 MS. O'DELL: If you'd give him a chance</p> <p>23 to finish.</p> <p>24 MR. FROST: I thought he did finish his</p> <p>25 question.</p>

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<p>1 MS. O'DELL: I don't think he did. I'm</p> <p>2 sure he needs to give you an opportunity to</p> <p>3 finish as well --</p> <p>4 MR. FROST: I'm sorry. I thought you had</p> <p>5 finished your question.</p> <p>6 MS. O'DELL: But you're talking over each</p> <p>7 other. In fact, you just interrupted me.</p> <p>8 A. That's why I was distracted. Can you</p> <p>9 restate your question again, please?</p> <p>10 BY MR. FROST:</p> <p>11 Q. Sure. So my question is: Every sample</p> <p>12 that comes out of a mine doesn't -- you know, everywhere</p> <p>13 they're sampling, they're doing core outside of the talc</p> <p>14 body. They're coring through. They're trying to find</p> <p>15 areas of ore they don't use. Do you agree with all</p> <p>16 these as just general mining concepts?</p> <p>17 A. Generally.</p> <p>18 Q. Okay.</p> <p>19 A. But it -- go ahead.</p> <p>20 Q. And you also agree with me that,</p> <p>21 generally, mines aren't just sampling from the ore they</p> <p>22 are using to put into a final product, correct?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. Correct. But that doesn't mean that --</p> <p>25 that doesn't mean that you're not, when you sample and</p>	<p>1 hypothetical questions here. I'm trying to get down to,</p> <p>2 and again, as part of the mining process, you sample to</p> <p>3 determine which parts of the ore you avoid and which</p> <p>4 parts of the ore you mine, right?</p> <p>5 A. Yes. That is a common procedure.</p> <p>6 Q. So just because a sample comes up and has</p> <p>7 a hit of a particular chemical in it doesn't necessarily</p> <p>8 mean that they then use that as a final product, because</p> <p>9 part of sampling is to tell you what parts of the mine</p> <p>10 to avoid, right?</p> <p>11 MS. SCOTT: Objection.</p> <p>12 A. Potentially. But there's reasonable</p> <p>13 risk. If you find it in one spot, it might be near</p> <p>14 another spot. When you have high concentrations, such</p> <p>15 as those observed, it's a natural. Essentially, you</p> <p>16 have gradients that occur over some degree of space. So</p> <p>17 you, you know, so arsenic might have, you know, a</p> <p>18 thousand parts per million in one spot and be zero in</p> <p>19 another, but without, you don't know where to mine,</p> <p>20 where that's cut -- cut off.</p> <p>21 BY MR. FROST:</p> <p>22 Q. But, again, but my question's very easy,</p> <p>23 and it's just because you see something here doesn't</p> <p>24 mean it's there, right? You'd have to know more?</p> <p>25 MS. SCOTT: Objection.</p>
Page 151	Page 153
<p>1 find things like asbestos, it doesn't negate that they</p> <p>2 exist.</p> <p>3 BY MR. FROST:</p> <p>4 Q. Okay. Here's my next question: Based on</p> <p>5 that, just because a sample comes back with a particular</p> <p>6 level of some, say, heavy metal, you know, just because</p> <p>7 some sample in a mine somewhere came up with a level of</p> <p>8 chromium, for example, based on that sample, you can't</p> <p>9 say, without knowing more, that that particular area</p> <p>10 where the sample came from ultimately ended up in talcum</p> <p>11 powder that consumers used, right?</p> <p>12 MS. SCOTT: Objection. Calls for</p> <p>13 speculation.</p> <p>14 A. So, yeah, I think it is speculative,</p> <p>15 because you're talking about one powder. There's many,</p> <p>16 many analyses of things. So you're not -- you're not</p> <p>17 gonna spend a huge amount of time on things that are not</p> <p>18 directly related to your work, because, you know, you do</p> <p>19 have to keep costs in mind. So, you know, if -- you</p> <p>20 know, there were numerous, numerous, numerous analyses</p> <p>21 of arsenic, for example, in some of the Vermont</p> <p>22 material. So, you know, some of those were related to</p> <p>23 ores. And let's look to --</p> <p>24 BY MR. FROST:</p> <p>25 Q. We don't need to. I'm asking very just</p>	<p>1 BY MR. FROST:</p> <p>2 Q. Right?</p> <p>3 A. Correct.</p> <p>4 Q. Okay. And just because something shows</p> <p>5 up here doesn't necessarily mean it's going to end up in</p> <p>6 what becomes the mill feed, right?</p> <p>7 MS. SCOTT: Objection.</p> <p>8 A. Correct. But there's always the</p> <p>9 potential for it to do so.</p> <p>10 BY MR. FROST:</p> <p>11 Q. Okay. And you also agree with me that</p> <p>12 beneficiation is one way that mines specifically for</p> <p>13 talc can clean out some of the accessory minerals and</p> <p>14 some of the heavy metals, right?</p> <p>15 MS. O'DELL: Object to the form.</p> <p>16 A. Beneficiation works when applied</p> <p>17 properly. I'm not a mineral engineer, so I don't fully</p> <p>18 think I can comment on details of that.</p> <p>19 BY MR. FROST:</p> <p>20 Q. Okay. But you agree with me that</p> <p>21 beneficiation is one way in which you can reduce the</p> <p>22 amount of, say, a heavy metal that ends up in a final</p> <p>23 product, correct?</p> <p>24 MS. SCOTT: Objection.</p> <p>25 A. I would rather not comment, so the --</p>

<p style="text-align: right;">Page 154</p> <p>1 BY MR. FROST:</p> <p>2 Q. You comment in your report specifically</p> <p>3 about the beneficiation going on at the Vermont mines.</p> <p>4 So is that not something you're going to opine on here?</p> <p>5 MS. SCOTT: Do you want to point him to</p> <p>6 the place in his report?</p> <p>7 A. Yeah. Sorry. Is this the Colorado mines</p> <p>8 study?</p> <p>9 BY MR. FROST:</p> <p>10 Q. Yeah, it might be. I don't have it right</p> <p>11 in front of me. It's something that I think we can get</p> <p>12 back to later. But you agree with me as a general</p> <p>13 mining concept --</p> <p>14 A. I'd like to see the document.</p> <p>15 Q. Yeah. Well, I'm asking you general</p> <p>16 concepts, because you are giving opinions about the</p> <p>17 mining that was going on at these mines, correct?</p> <p>18 A. Yes.</p> <p>19 Q. And beneficiation is one thing that mines</p> <p>20 use, correct?</p> <p>21 A. Yes.</p> <p>22 Q. And beneficiation can be used to reduce</p> <p>23 the amount of contaminants that are in an ore, correct?</p> <p>24 MS. SCOTT: Objection.</p> <p>25 MS. O'DELL: Objection to form.</p>	<p style="text-align: right;">Page 156</p> <p>1 beforehand, and basically, they walked away with \$50,000</p> <p>2 worth of aquamarines. So gem mining certainly is</p> <p>3 something that you could selectively mine.</p> <p>4 Gold is another example where there are</p> <p>5 deposits in Nigeria where, essentially, groups of women</p> <p>6 go out and they selectively, you know, go through,</p> <p>7 basically pan and find gold nuggets. I think it's --</p> <p>8 you know, it really depends on how you say selective</p> <p>9 mining, and so the thing that, you know -- did I answer</p> <p>10 that?</p> <p>11 Q. I'm listening to your explanation, yeah.</p> <p>12 A. Okay. So selective mining, I think in</p> <p>13 the context of talc deposits, is -- I really don't think</p> <p>14 you can effectively do it. So with respect to Chinese</p> <p>15 ore that is supposedly hand sorted -- let me find where</p> <p>16 that section is. So if you're -- yeah, as I understand</p> <p>17 it, they basically look at the rock and say it's okay.</p> <p>18 There's nothing wrong.</p> <p>19 Well, there's several issues with that.</p> <p>20 So, one, the human eye cannot detect either metals or</p> <p>21 small asbestos fibers by simply looking at, at the rock,</p> <p>22 at the surface of the rock, right? So, essentially, you</p> <p>23 can do it. You can visually inspect the outside of the</p> <p>24 material, and you would not be able to visibly see if</p> <p>25 there's a thousand parts per million of nickel or</p>
<p style="text-align: right;">Page 155</p> <p>1 A. Reduce, but not purify.</p> <p>2 BY MR. FROST:</p> <p>3 Q. It can be used to reduce, correct?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. Potentially, if executed well.</p> <p>6 BY MR. FROST:</p> <p>7 Q. Okay. And selective mining is another</p> <p>8 tactic that can be used in an ore to try to reduce</p> <p>9 contaminates, correct?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. No. There's -- the selective mining was</p> <p>12 an issue, significant issue that I found. And the</p> <p>13 reason --</p> <p>14 BY MR. FROST:</p> <p>15 Q. I'm asking in general, sir. Can</p> <p>16 selective mining --</p> <p>17 A. In general, I don't -- you know, I think</p> <p>18 it really depends on what you mean by "selective</p> <p>19 mining." So I think a good effective example of</p> <p>20 selective mining would be gemstones. So you find a</p> <p>21 pegmatite. You go -- actually, there was a group that</p> <p>22 did this a couple years ago. They went to a site in</p> <p>23 Colorado. They basically looked at the geology. They</p> <p>24 selectively looked at specific lithologies. They were</p> <p>25 able to narrow it down. They did a lot of research</p>	<p style="text-align: right;">Page 157</p> <p>1 chromium or some other element.</p> <p>2 And then, in addition, you can have</p> <p>3 inclusions of stuff in the rock that you could not --</p> <p>4 you just physically can't see. So there's a</p> <p>5 hypothetical risk that you can have inclusion of, let's</p> <p>6 say, sulfides, a lot of sulfides, a nodule that has a</p> <p>7 lot of sulfides in it, that, in this chunk, you would</p> <p>8 not be able to visually discern what was there. So and</p> <p>9 then, you know, so you basically -- and so that's the</p> <p>10 sorting, as I understand it, with China.</p> <p>11 Q. Do you agree with me that -- so, is it</p> <p>12 your opinion that selective mining for talc can never</p> <p>13 work or do you agree with me that selective mining is</p> <p>14 one of the tools that a mine can use to help to purify</p> <p>15 its ore?</p> <p>16 A. I would say in the context of -- in the</p> <p>17 context of talc, selective mining is not very effective,</p> <p>18 because the scale of the issue is with the ore.</p> <p>19 Q. Okay. Other than your personal opinion,</p> <p>20 can you cite to me any peer-reviewed or scientific</p> <p>21 source that supports that?</p> <p>22 MS. SCOTT: Objection.</p> <p>23 A. I don't think there's any peer-reviewed</p> <p>24 literature that I can think of. I think it's just</p> <p>25 common sense. You know, everyone knows that you can</p>

<p style="text-align: right;">Page 158</p> <p>1 hide -- you can have inclusions and impurities in an 2 ore. And if you're only using your eyes and you're only 3 hand sorting things -- plus there's human error. 4 There's just simply human error. If someone, you know, 5 is, you know -- they'll just make mistakes. 6 And then the other issue I think is 7 unclear, I didn't find any degree of training, you know, 8 or no description of the training methods that were used 9 for hand sorting. So an ore-controlled geologist is a 10 common, common position in mines. 11 One of my former students, he's an 12 ore-controlled geologist in Stillwater, and it takes 13 three months of training for them to delineate the ore. 14 So that is an example of selective mining, but there's a 15 high level of effort that goes into it, and the goal is 16 platinum. And, basically, the way that particular mine 17 is set up is to extract the platinum. They're not 18 really -- they don't have to worry about other 19 contaminants that might be present. 20 BY MR. FROST: 21 Q. Okay. I'm going to stop you because we 22 keep getting off on a lot of these tangents. My 23 question was: Can you point me to any mining studies or 24 anything else that say that selective mining does not 25 work for talc?</p>	<p style="text-align: right;">Page 160</p> <p>1 basis of this is Van Gosen 2004. I'm going to mark 2 that. 3 A. Okay. It's the environmental earth 4 science paper? 5 Q. What's that? 6 A. It's the environmental earth science 7 paper? It's the journal? 8 Q. Yes. Environmental Geology, 2004. 9 A. Oh, yeah. That's currently -- the 10 journal name changed. I had a few papers in it. Is 11 there a copy of it? 12 Q. The court reporter's marking it. 13 (Exhibit 11 was marked for 14 identification.) 15 BY MR. FROST: 16 Q. Since we've already established we're 17 talking about the same paper, can you show me anywhere 18 in this paper that Van Gosen specifically speaks about 19 any of the mines that you've listed here in your report? 20 A. Correct. No specific mine is listed. It 21 talks about Vermont talc, in general. 22 (Exhibit 12 was marked for 23 identification.) 24 BY MR. FROST: 25 Q. I've now marked the Ross article. It's</p>
<p style="text-align: right;">Page 159</p> <p>1 A. I know of no peer-review publications. 2 Q. Okay. Thank you. Turn to page 7 of your 3 report. It's 7 into 8, actually. You know, we start 4 talking about the various regions that talc is sourced 5 from, correct? 6 A. Yes. 7 Q. Okay. On page 7 to 8, you list various 8 time frames and various mines, you know, from which you 9 believe. I take it this came from your review of the 10 documents, the timeline that you put forth here? 11 A. Just give me a moment to review. 12 Q. The easier way to ask is: Is this 13 something that was provided to you or is this something 14 that you came up with yourself? 15 A. I came up with it. 16 Q. Okay. So at the very end of it, so we 17 talked about all the various mines, and afterwards, you 18 have a sentence that reads, "These mines are known to 19 have impurities associated with talc, including toxic 20 metals, chrysotile, and amphibole asbestos." Do you see 21 that? 22 MS. O'DELL: Objection to form. 23 A. Yes. 24 BY MR. FROST: 25 Q. Okay. So the first thing you note as the</p>	<p style="text-align: right;">Page 161</p> <p>1 Ross 74. "Environmental Health Perspectives." She's 2 already marked it for you. 3 A. Oh. 4 Q. Same question. Can you show me where in 5 this article it details any mine actually used by 6 Johnson & Johnson? 7 MS. SCOTT: Objection. 8 A. I don't see mention of a specific mine. 9 BY MR. FROST: 10 Q. Next, I'm going to mark -- I'm sorry. 11 A. Go ahead. 12 Q. I didn't mean to cut you off if you 13 weren't done. Next I'm going to mark Document 14 JNJ 000521616, the first page of it, anyway. 15 (Exhibit 13 was marked for 16 identification.) 17 BY MR. FROST: 18 Q. Do you remember looking at this document? 19 A. Actually, I'm unsure. 20 Q. Okay. 21 A. I might have used the wrong number. 22 Q. Okay. But you agree with me this doesn't 23 talk about any of the mines, certainly, right? 24 A. Right. Yeah. 25 MS. SCOTT: Object to form.</p>

<p style="text-align: right;">Page 162</p> <p>1 MS. O'DELL: Object to form.</p> <p>2 A. Correct. I -- I haven't -- I don't think</p> <p>3 I've seen this. I think I used -- there's a typo or</p> <p>4 something in there. Sorry.</p> <p>5 BY MR. FROST:</p> <p>6 Q. No. That's okay. That's why we're --</p> <p>7 that's why we're doing this.</p> <p>8 All right. If you turn to page 14 of</p> <p>9 your report under, "Evidence that Asbestos Occurred in</p> <p>10 Defendants' Mines." The first sentence reads, "The</p> <p>11 documents I reviewed provided strong evidence that the</p> <p>12 talc used by Imerys and Johnson & Johnson to produce</p> <p>13 Johnson's Baby Powder and Shower to Shower came from</p> <p>14 mines that contained asbestos minerals or fibrous talcum</p> <p>15 in an asbestiform habit." Did I read that right?</p> <p>16 A. Yes.</p> <p>17 Q. And looking back, you cite the same exact</p> <p>18 documents as we just -- as the last sentence, correct?</p> <p>19 MS. SCOTT: Objection.</p> <p>20 A. It's in the report.</p> <p>21 BY MR. FROST:</p> <p>22 Q. Yeah. Okay. And you'd agree with me,</p> <p>23 you know, that these materials don't actually relate</p> <p>24 directly to the mines used by Johnson & Johnson as</p> <p>25 identified on pages -- I believe it's 7 and 8 of your</p>	<p style="text-align: right;">Page 164</p> <p>1 as amphibole and grit and stuff like that, correct?</p> <p>2 A. So, for example, the one ending in 87231,</p> <p>3 "Battelle Memorial Institute document dated 1958,</p> <p>4 indicated the presence of tremolite in the talc,</p> <p>5 commonly at levels ranging from 1-3 percent. That</p> <p>6 document also studied the abrasiveness and grit of</p> <p>7 Italian talc." So that's something, that the grit is in</p> <p>8 addition to the finding of tremolite.</p> <p>9 Q. Do you agree with me that none of these</p> <p>10 documents actually find asbestos or define that they</p> <p>11 have found asbestos in any of the ore from Italy?</p> <p>12 MS. O'DELL: Object to the form.</p> <p>13 A. I would want to double-check all of</p> <p>14 these, but they do two things. The last one, presence</p> <p>15 of tremolite and actinolite and, also, tremolite and one</p> <p>16 that I just mentioned. And tremolite is a -- recognized</p> <p>17 as a carcinogen by IARC 2012.</p> <p>18 Q. Can you show me anywhere in your report</p> <p>19 that you note that tremolite is found by IARC to be a</p> <p>20 potentially dangerous mineral, you know, a human</p> <p>21 carcinogen?</p> <p>22 (Exhibit 14 was marked for</p> <p>23 identification.)</p> <p>24 A. I can't find a specific example.</p> <p>25</p>
<p style="text-align: right;">Page 163</p> <p>1 report, right?</p> <p>2 MS. SCOTT: Objection.</p> <p>3 MS. O'DELL: Objection to form.</p> <p>4 A. I would have to read -- double -- I would</p> <p>5 want to double-check each individual document.</p> <p>6 BY MR. FROST:</p> <p>7 Q. But, certainly, the ones we just looked</p> <p>8 at --</p> <p>9 A. The one we just looked at.</p> <p>10 Q. -- certainly don't support that, right?</p> <p>11 A. Correct.</p> <p>12 Q. Okay. All right. Move on to the next</p> <p>13 section of the report. It's "Mines in Italy," pages 8</p> <p>14 to 9, I believe, of your report.</p> <p>15 A. Oh, 8 to 9.</p> <p>16 Q. Then on page 9, it's the third paragraph.</p> <p>17 You have, "Based on what I have reviewed, I have</p> <p>18 sufficient basis to conclude that Italian ore was of</p> <p>19 poor quality," correct?</p> <p>20 A. Yes.</p> <p>21 Q. What are you talking about there when you</p> <p>22 say "poor quality"?</p> <p>23 A. That I'm referring to the findings of the</p> <p>24 items listed below.</p> <p>25 Q. These items are talking about things such</p>	<p style="text-align: right;">Page 165</p> <p>1 BY MR. FROST:</p> <p>2 Q. And you're not qualified to say whether</p> <p>3 or not a particular mineral would be harmful, you know,</p> <p>4 as a human carcinogen. You have no basis by which to</p> <p>5 say that's correct or not correct, right?</p> <p>6 MS. SCOTT: Objection.</p> <p>7 A. Correct. I'm not a medical.</p> <p>8 BY MR. FROST:</p> <p>9 Q. Okay. All right. What number was that?</p> <p>10 Fourteen. So I've just marked -- I've given you a</p> <p>11 binder marked 14. It has tabs 1 through 5. I'm sorry.</p> <p>12 I have yours. I apologize.</p> <p>13 So these are the various documents you</p> <p>14 cite in your report. So let's look through each of</p> <p>15 them. We'll start with 1.</p> <p>16 MS. O'DELL: Let's get this one back</p> <p>17 together.</p> <p>18 MR. FROST: Oh, did it come apart?</p> <p>19 MS. O'DELL: Yes. Is there a particular</p> <p>20 part of his report that these came from or are</p> <p>21 you jumping around?</p> <p>22 MR. FROST: Yes. No, we're talking about</p> <p>23 the report now. They're page 9 to 10. These</p> <p>24 are the documents that support the</p> <p>25 ore-is-of-poor-quality statement.</p>

<p style="text-align: right;">Page 166</p> <p>1 BY MR. FROST:</p> <p>2 Q. So this first one, can you tell me</p> <p>3 anywhere in the Battelle report that starts JNJ 87868,</p> <p>4 that they note the trace amounts of amphibole are</p> <p>5 asbestiform in any way?</p> <p>6 MS. O'DELL: Object to the form.</p> <p>7 A. No, I don't.</p> <p>8 BY MR. FROST:</p> <p>9 Q. Okay. Turn to tab 2, which is -- the</p> <p>10 document starts JNJ 87231. Same question. Can you tell</p> <p>11 me anywhere in here where, I believe it's Battelle</p> <p>12 again, identifies finding any asbestiform mineral?</p> <p>13 MS. SCOTT: Objection.</p> <p>14 A. So tremolite is noted as trace on page 4</p> <p>15 here.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Does it note the trace tremolite has</p> <p>18 asbestiform?</p> <p>19 A. No, it does not.</p> <p>20 Q. So you'd have no way to tell whether or</p> <p>21 not it's asbestiform or non-asbestiform based on this</p> <p>22 document?</p> <p>23 MS. O'DELL: Object to form.</p> <p>24 MS. SCOTT: Objection.</p> <p>25 A. The -- it has been so, "The amphibole</p>	<p style="text-align: right;">Page 168</p> <p>1 BY MR. FROST:</p> <p>2 Q. But it's JNJAZ55_6104. I think it starts</p> <p>3 at 6103, but 6104 is the letter. The one, two, three --</p> <p>4 fourth paragraph down says, "I have also checked into</p> <p>5 the mineralization of that part of the territory, and</p> <p>6 the minerals which show in the valley are: Talc,</p> <p>7 pyrite," magnesite -- sorry, "magnetite, calcite,</p> <p>8 dolomite, apatite, clinocllore," sorry, "chrysotile,"</p> <p>9 and then, you know, talks about others, including</p> <p>10 tremolite, actinolite, correct?</p> <p>11 A. Yes.</p> <p>12 Q. And this is talking about the valley.</p> <p>13 There is nothing in here that indicates that this is</p> <p>14 talking specifically about the Fontaine mine, correct?</p> <p>15 MS. SCOTT: Objection.</p> <p>16 MS. O'DELL: Objection.</p> <p>17 A. It's unclear.</p> <p>18 BY MR. FROST:</p> <p>19 Q. Dr. Ashton also isn't saying that any of</p> <p>20 these minerals have been found in the ore coming from</p> <p>21 the Fontaine mine, correct?</p> <p>22 MS. O'DELL: Objection to form.</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. Correct, but mineralization of that part</p> <p>25 of the territory. So...</p>
<p style="text-align: right;">Page 167</p> <p>1 component has been established to be the variety of</p> <p>2 tremolite." Yeah. It does not say that it is asbestos</p> <p>3 form, but it is tremolite.</p> <p>4 BY MR. FROST:</p> <p>5 Q. Okay. Turn to tab 17 -- or sorry, tab 3.</p> <p>6 It's the document Bates numbered JNJAZ55_213.</p> <p>7 And, again, I think it mentions tremolite</p> <p>8 and actinolite as things that may be in the ore, but it</p> <p>9 doesn't talk about whether or not anything's asbestiform</p> <p>10 or any levels, correct?</p> <p>11 A. True. It does say tremolite and</p> <p>12 actinolite.</p> <p>13 Q. Turn to tab 4. Somebody's conveniently</p> <p>14 put an arrow, I think, to the paragraph that you're</p> <p>15 relying on. It states -- sorry, this is the document</p> <p>16 that starts JNJAZ --</p> <p>17 MS. O'DELL: Just to make clear --</p> <p>18 MR. FROST: It's on the document.</p> <p>19 MS. O'DELL: It's the original.</p> <p>20 MR. FROST: Yeah. I was going to say,</p> <p>21 it's not something we've done.</p> <p>22 MS. SCOTT: Or anyone else?</p> <p>23 MR. FROST: Yes. It's part of the</p> <p>24 original document as produced.</p> <p>25</p>	<p style="text-align: right;">Page 169</p> <p>1 BY MR. FROST:</p> <p>2 Q. But there can be different mineral</p> <p>3 profiles throughout the valley depending on when it</p> <p>4 formed, what it formed from?</p> <p>5 A. Yes, and it could be present because of</p> <p>6 the association observed.</p> <p>7 Q. Unfortunately, there's just no way to</p> <p>8 tell from this document, correct?</p> <p>9 MS. SCOTT: Objection.</p> <p>10 MS. O'DELL: Object to form.</p> <p>11 A. Correct.</p> <p>12 BY MR. FROST:</p> <p>13 Q. All right. Turn to tab 5. It's the</p> <p>14 document that starts JNJAZ_87. This is the Pooley</p> <p>15 report from 1972. It's very long, so I'll help you out.</p> <p>16 If you turn to the very end of it --</p> <p>17 MS. O'DELL: Doctor, feel free to --</p> <p>18 BY MR. FROST:</p> <p>19 Q. Yeah. I was going to say, you can review</p> <p>20 the whole thing if you want, but I'm going to</p> <p>21 concentrate on the "Conclusions" section.</p> <p>22 If you look at -- it's on page 121 of the</p> <p>23 report.</p> <p>24 A. Oh, this one.</p> <p>25 Q. Do you recognize that you've seen this</p>

<p style="text-align: right;">Page 170</p> <p>1 one?</p> <p>2 A. Yeah.</p> <p>3 Q. The quality's bad.</p> <p>4 A. Oh, there's -- you can see chrysotile.</p> <p>5 "Examples of commercial amphibole and chrysotile</p> <p>6 asbestos particles together with typical selected area</p> <p>7 electron diffraction patterns." Yeah. So the images</p> <p>8 are here, but, yeah. So, yeah. That's right. That</p> <p>9 page you can't tell.</p> <p>10 MS. O'DELL: What page are you on?</p> <p>11 THE WITNESS: I'm on Page 56. I'm sorry.</p> <p>12 MS. O'DELL: Yeah. No, no. I'm just</p> <p>13 trying to follow along. You go where you need</p> <p>14 to go.</p> <p>15 A. Amosite asbestos particles there.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Again, the chrysotile you pointed out on</p> <p>18 56, he's showing you an example of what a commercial</p> <p>19 chrysotile looks like, right, not a picture of what came</p> <p>20 from the talc. Do you agree?</p> <p>21 MS. O'DELL: Object to the form.</p> <p>22 A. What's your question?</p> <p>23 BY MR. FROST:</p> <p>24 Q. When you just talked about 56, the</p> <p>25 picture of chrysotile you're talking about is a</p>	<p style="text-align: right;">Page 172</p> <p>1 formed from the amphibole mineral found at the mine were</p> <p>2 hardly fibrous in character, the majority of the</p> <p>3 tremolite breaking to give compact particles," correct?</p> <p>4 A. It also said, "Those fibres formed were</p> <p>5 short and had a very large diameter." So fibers were</p> <p>6 formed. But, yeah, you're correct.</p> <p>7 Q. So, again, it's his opinion that there</p> <p>8 was no asbestos in that test, correct?</p> <p>9 MS. O'DELL: Object to the form.</p> <p>10 MS. SCOTT: Objection.</p> <p>11 BY MR. FROST:</p> <p>12 Q. But that the tremolite was not</p> <p>13 asbestiform. I think they were just called the</p> <p>14 amphibole, but the amphibole that he found was not</p> <p>15 asbestos, correct?</p> <p>16 A. Correct.</p> <p>17 Q. Turning back to your report, page 10, the</p> <p>18 "Mines in Vermont." So I think we talked about it a</p> <p>19 little bit, but I think you and I will agree the</p> <p>20 Appalachian ultramafic belt is where the talc is found</p> <p>21 in Vermont, correct? I think it's your second sentence.</p> <p>22 A. Yes. Yeah.</p> <p>23 Q. Now, do you have the opinion that all the</p> <p>24 ultramafic rocks within the Appalachian belt had the</p> <p>25 same general metamorphic histories and formation</p>
<p style="text-align: right;">Page 171</p> <p>1 reference to --</p> <p>2 A. I just recognized it.</p> <p>3 Q. Okay.</p> <p>4 MS. O'DELL: Object to the form.</p> <p>5 BY MR. FROST:</p> <p>6 Q. So if you look at the fourth paragraph</p> <p>7 down on page 121, Pooley's page 121, it's page 210 of</p> <p>8 the Bates number. The conclusion is "The only</p> <p>9 asbestos-type mineral to be detected in the hand samples</p> <p>10 was tremolite, which was found in three specimens." If</p> <p>11 you go down to the next sentence, it says, "no tremolite</p> <p>12 was detected in the talc-type specimens." Is that</p> <p>13 right?</p> <p>14 MS. O'DELL: Object to the form.</p> <p>15 A. That's what it says, yes.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Okay. So, again, Pooley did not find any</p> <p>18 tremolite in the actual ore or the talc, correct?</p> <p>19 MS. O'DELL: Object to the form.</p> <p>20 MS. SCOTT: Objection.</p> <p>21 A. As it reads, yes.</p> <p>22 BY MR. FROST:</p> <p>23 Q. And if you go to the next page, page 122,</p> <p>24 it's the first full paragraph, the second paragraph on</p> <p>25 the page. About halfway down, it reads, "Particles</p>	<p style="text-align: right;">Page 173</p> <p>1 histories and profiles?</p> <p>2 A. No. There would be some variability.</p> <p>3 Q. Okay. I agree with you. So have you</p> <p>4 ever looked at the local geology for the formation</p> <p>5 associated with the Hammondsville mine?</p> <p>6 A. I've never been on site. I've never been</p> <p>7 to the mine.</p> <p>8 Q. Have you ever looked at any geological</p> <p>9 survey specific to the Hammondsville mine deposit?</p> <p>10 A. The Hammondsville?</p> <p>11 Q. Yes.</p> <p>12 A. Yeah. Yeah. I see its geological</p> <p>13 survey.</p> <p>14 Q. I see the one you've typed here. That's</p> <p>15 really just geological survey showing you where it is,</p> <p>16 correct? That doesn't tell you about the morphology and</p> <p>17 the geological deposit formation?</p> <p>18 A. I think there's some geologic data that's</p> <p>19 associated with it. I don't remember specifics.</p> <p>20 Q. Okay. So and this is true for -- it's</p> <p>21 27, 28, 29 and 30, your footnotes, correct? These are</p> <p>22 all, you know, USGS website hits for Hamm, et cetera?</p> <p>23 A. Yeah.</p> <p>24 Q. Have you ever looked at any of the USGS</p> <p>25 actual reports or surveys that were done examining the</p>

<p style="text-align: right;">Page 174</p> <p>1 talc in these particular mines?</p> <p>2 A. I believe I have.</p> <p>3 Q. Do you recall which ones they are?</p> <p>4 A. Not specifically at the moment.</p> <p>5 MS. SCOTT: Before you get into this</p> <p>6 next --</p> <p>7 MR. FROST: Do you want to take a break?</p> <p>8 MS. SCOTT: Yeah, let's do that. We've</p> <p>9 been going about an hour and a half, I think, is</p> <p>10 that right, or about an hour?</p> <p>11 MS. O'DELL: Hour and 13 minutes.</p> <p>12 VIDEOGRAPHER: We're now going off the</p> <p>13 record. The time is 2:39.</p> <p>14 (A recess was taken from 2:39 to 2:58)</p> <p>15 VIDEOGRAPHER: We're now back on record,</p> <p>16 and the time is 2:58.</p> <p>17 (Exhibit 15 was marked for</p> <p>18 identification.)</p> <p>19 BY MR. FROST:</p> <p>20 Q. All right. I'm going to start -- can you</p> <p>21 grab, I think, number 15? It's the 1951 geological</p> <p>22 survey from Chidester. Have you ever seen this article</p> <p>23 before?</p> <p>24 A. I don't remember. Let me look at my</p> <p>25 references, the author or the agency. It doesn't appear</p>	<p style="text-align: right;">Page 176</p> <p>1 geological survey?</p> <p>2 A. As stated, yeah.</p> <p>3 Q. Any reason this would not have come up in</p> <p>4 your search?</p> <p>5 MS. SCOTT: Objection.</p> <p>6 A. I didn't search for this particular</p> <p>7 document. When I was doing my search for the</p> <p>8 peer-review literature, you know, I use, like, Web of</p> <p>9 Science. So Web of Science has, essentially, this</p> <p>10 higher level of peer-review material. So this isn't</p> <p>11 necessarily -- these types of reports aren't included in</p> <p>12 that, but I did use Google to search things, and that's</p> <p>13 how I found some of the other things. So -- but, no, I</p> <p>14 don't believe that I've seen this report.</p> <p>15 BY MR. FROST:</p> <p>16 Q. Okay. Given your rendering opinions</p> <p>17 about the geology specifically at the Vermont talc</p> <p>18 deposits, any particular reason you didn't search the</p> <p>19 geological surveys, the USGS surveys regarding the</p> <p>20 areas?</p> <p>21 MS. SCOTT: Objection.</p> <p>22 A. I looked at the literature that I thought</p> <p>23 was relevant, based on my professional opinion.</p> <p>24 BY MR. FROST:</p> <p>25 Q. The next one marked. Take a look at --</p>
<p style="text-align: right;">Page 175</p> <p>1 to be on my reference list.</p> <p>2 Q. Okay. Turn to page 28 of the report.</p> <p>3 MS. SCOTT: And, Doctor, feel free to</p> <p>4 take a look at the entirety of the report if you</p> <p>5 need to.</p> <p>6 A. Okay. I'm not sure.</p> <p>7 MS. SCOTT: Do you have one?</p> <p>8 MR. FROST: Do you need a copy?</p> <p>9 MS. SCOTT: Yes.</p> <p>10 MR. FROST: I apologize.</p> <p>11 MS. SCOTT: That's okay. Thanks.</p> <p>12 MR. FROST: You're welcome. Sorry about</p> <p>13 that.</p> <p>14 MS. SCOTT: No problem.</p> <p>15 BY MR. FROST:</p> <p>16 Q. And my question about this paper is: You</p> <p>17 agree with me, turning to page 28, that this geological</p> <p>18 survey specifically talks about the Hammondsville talc</p> <p>19 mine, correct?</p> <p>20 A. Turn to page 28. Let's see here.</p> <p>21 Q. About halfway down the first column,</p> <p>22 "Hammondsville talc quarry, Locality 117."</p> <p>23 A. 28, Locality 117. Okay. I see that.</p> <p>24 Q. So you agree with me this paper talks</p> <p>25 about the Hammondsville talc mine, correct, this</p>	<p style="text-align: right;">Page 177</p> <p>1 yep, the next one.</p> <p>2 MS. O'DELL: What's the exhibit number on</p> <p>3 this one?</p> <p>4 MR. FROST: Sixteen.</p> <p>5 (Exhibit 16 was marked for</p> <p>6 identification.)</p> <p>7 BY MR. FROST:</p> <p>8 Q. And, again, this is Chidester 1964.</p> <p>9 A. It's the geological survey. Let me check</p> <p>10 and see if I have that. It doesn't look like I have</p> <p>11 that in the reference list.</p> <p>12 Q. Turn to pages --</p> <p>13 A. So let me look. Can I look at the report</p> <p>14 and --</p> <p>15 Q. Yes.</p> <p>16 A. -- just see what the nature is?</p> <p>17 Q. Sure. And, specifically, I'm going to</p> <p>18 turn your attention to 48 and 49.</p> <p>19 A. 48 and 49, okay. Let me look at the</p> <p>20 report in general here.</p> <p>21 Q. The question, then, is going to be: You</p> <p>22 agree with me that in this USGS survey, they</p> <p>23 specifically ran chemical analysis of ore coming out of</p> <p>24 the Hammondsville mine? I guess it's typed ore mill</p> <p>25 product.</p>

<p style="text-align: right;">Page 178</p> <p>1 A. Yes. It says, "Chemical analyses of a 2 variety of talc in Vermont," and the year on this is -- 3 well, I'm sorry. 4 Q. I believe it's 19 -- 5 A. So 40a, 40b and 40c. The source is from 6 Spence, so let's see what Spence 1940 is. So at that 7 period of time, most things were done by wet chemistry, 8 and so the -- there were limitations as far as the 9 detection limits. So I'm sorry. 1940. 10 Q. Well, again, my question -- 11 A. Yeah. Go ahead with your question. 12 Q. Despite the fact that there is specific 13 testing of ore in this document as well as Spence, 14 neither of those two documents ever came up in your 15 searches, correct? 16 MS. SCOTT: Objection. 17 BY MR. FROST: 18 Q. And this is testing specific to the ore 19 from the Hammondsville mine. Do you agree with me that 20 neither Spence nor this paper came up in your searches? 21 A. Correct. I mean, you know, so one of the 22 things is that it depends -- 23 Q. Well, answer my question. 24 A. Yep. I'm seeing if it -- it's not -- 25 actually, Spence is not cited in this document.</p>	<p style="text-align: right;">Page 180</p> <p>1 MS. O'DELL: Let him finish. 2 A. Power diffraction was beginning to be 3 common and then chemical analyses. So I didn't 4 necessarily exclude it based on -- or I didn't really -- 5 I just -- I didn't find it, but I didn't -- you know, 6 these are older references and I would not -- 7 BY MR. FROST: 8 Q. That was question is you didn't find 9 this, right? 10 MS. SCOTT: Objection. 11 A. I did not search for a lot of the older 12 literature because the analytical methods dated, 13 predated what appear to be the operational -- operation 14 timelines or -- 15 BY MR. FROST: 16 Q. But it doesn't sound like you searched 17 for any USGS surveys regarding these specific mines; is 18 that fair? That wouldn't have come up in your search? 19 MS. SCOTT: Objection. 20 A. So specific mines may not -- they're not 21 necessarily in USGS reports. Mines tend to show up in 22 USGS reports if there's permission or -- 23 BY MR. FROST: 24 Q. Sir, I have a limited amount of time, and 25 I really need you to just answer my questions. So my</p>
<p style="text-align: right;">Page 179</p> <p>1 Q. It appears to be. Spence? 2 A. Pearre, Pearre, Pearre, Pearre, Perry, 3 Pratt, Quinn. 4 Q. If you at page 61, Spence, HS 1940. 5 A. It's not listed in the -- 6 Q. Page 61, selected bibliography? 7 A. 61. I'm sorry. I don't see it. Oh, 8 Spence. I was thinking Pence. Okay. Right. Very 9 good. 10 Q. Okay. 11 A. So, essentially, the -- I don't think the 12 company was mining Hammondsville at that time, was it? 13 Q. My question becomes, did these come up -- 14 despite the fact that there's testing specifically of 15 ore from Hammondsville in both Spence and this, this 16 report did not come up or the Spence report come up in 17 your searches; is that correct? 18 MS. SCOTT: Objection. 19 A. Correct, because the analytical 20 techniques at the time, certainly for electron 21 microscopy, was in its infancy. Power diffraction 22 was -- 23 BY MR. FROST: 24 Q. So you're saying it didn't come up in 25 your computer search because of --</p>	<p style="text-align: right;">Page 181</p> <p>1 question is -- 2 A. I'm trying to give a thorough answer. 3 Q. No, no. The question is -- it's a very 4 simple question. Did you search USGS reports for the 5 specific mines that Johnson & Johnson used in Vermont? 6 MS. SCOTT: Objection. 7 A. I don't remember. 8 BY MR. FROST: 9 Q. Okay. And you certainly didn't cite 10 them. 11 A. I did not cite these. I did not cite 12 these. 13 Q. Do you know what NIOSH is? 14 A. Yes. 15 Q. Okay. Are you aware that NIOSH has 16 funded an epidemiological study based out of the workers 17 of the Vermont mines? 18 MS. SCOTT: Objection. 19 A. I'm not a medical expert. I only know 20 NIOSH really exists. I use it for the basic definition. 21 BY MR. FROST: 22 Q. So is that a no? 23 A. I'm sorry. Repeat the question, please. 24 Q. I said, are you aware that NIOSH has run 25 an epidemiological study of the workers at the Vermont</p>

<p style="text-align: right;">Page 182</p> <p>1 mines?</p> <p>2 A. No I am not. I don't remember.</p> <p>3 MR. FROST: We'll mark this as -- I</p> <p>4 believe this is new 17.</p> <p>5 (Exhibit 17 was marked for</p> <p>6 identification.)</p> <p>7 BY MR. FROST:</p> <p>8 Q. Have you ever seen this paper? Do you</p> <p>9 know who Dr. Boundy is?</p> <p>10 A. So what is the journal? I don't have it</p> <p>11 cited as Boundy. The journal -- is this a National</p> <p>12 Institutes of Health paper, just so I can be sure?</p> <p>13 Q. I believe it is a journal called Dust and</p> <p>14 Disease.</p> <p>15 A. Oh, I don't think I cited anything from</p> <p>16 Dust and Disease.</p> <p>17 Q. Okay.</p> <p>18 A. So in occupational exposures,</p> <p>19 non-asbestiform talc in Vermont. Okay?</p> <p>20 Q. Is this not something that came up in</p> <p>21 your search?</p> <p>22 MS. SCOTT: Objection.</p> <p>23 A. No. I'm not -- I'm sorry. Dust and</p> <p>24 Disease?</p> <p>25</p>	<p style="text-align: right;">Page 184</p> <p>1 explanations about other parts of the report that don't</p> <p>2 have to do with question are just taking up my time on</p> <p>3 the record. So I'm not trying to be rude, but I'm</p> <p>4 running out of time, so I'm trying to move it along.</p> <p>5 MS. SCOTT: But to be fair, you're also</p> <p>6 asking him about an epidemiological study. He's</p> <p>7 not an epidemiologist.</p> <p>8 BY MR. FROST:</p> <p>9 Q. And my question was whether or not this</p> <p>10 was something he would have searched for, and the answer</p> <p>11 is no, right?</p> <p>12 A. No. I would not go to a journal called</p> <p>13 Dust and Disease. Are you okay on time?</p> <p>14 Q. You don't need to worry about that.</p> <p>15 That's a lawyer thing.</p> <p>16 MS. O'DELL: Yes.</p> <p>17 BY MR. FROST:</p> <p>18 Q. Turning back to your report, looking at</p> <p>19 the bottom of page 10, we then move on to the mines in</p> <p>20 China.</p> <p>21 A. I requested documents on -- I requested</p> <p>22 documents on China, mines in China. There were --</p> <p>23 apparently, there was not a whole lot of information. I</p> <p>24 know Dr. Longo tested materials from China, but I don't</p> <p>25 think -- I mean, I made a request for cores. I made</p>
<p style="text-align: right;">Page 183</p> <p>1 BY MR. FROST:</p> <p>2 Q. That's correct.</p> <p>3 A. Yeah. I'm not a medical --</p> <p>4 Q. So you wouldn't have --</p> <p>5 A. -- expert.</p> <p>6 Q. Sorry.</p> <p>7 A. So I'm not a medical expert, so I didn't.</p> <p>8 Q. So you wouldn't have looked at any</p> <p>9 journals outside of your specific field, because I will</p> <p>10 relate to you that they tested talc from the various</p> <p>11 mines and found that there was no asbestos in it based</p> <p>12 on the NIOSH study. It's not something you relied on?</p> <p>13 A. So there's --</p> <p>14 MS. O'DELL: Object to the form. Excuse</p> <p>15 me, Doctor. Object to the form. You may</p> <p>16 answer.</p> <p>17 A. In all these questions are still -- I did</p> <p>18 not look at this paper, but this paper does not negate</p> <p>19 the findings of the rest of the report. I've tried to</p> <p>20 take a broad net.</p> <p>21 BY MR. FROST:</p> <p>22 Q. Sir, again --</p> <p>23 A. I have a broad net.</p> <p>24 Q. I'm asking very simply yes or no</p> <p>25 questions about whether he searched for things,</p>	<p style="text-align: right;">Page 185</p> <p>1 requests for testing results, including TEM, XRD, bulk</p> <p>2 chemistry. But the data that I was able to have was, as</p> <p>3 far as I did actually, I tried to search on Web of</p> <p>4 Science and other things about talc deposits in China,</p> <p>5 and I could not discernibly find anything. I think</p> <p>6 there's Chinese references, but I don't speak Chinese</p> <p>7 and --</p> <p>8 Q. Sure.</p> <p>9 A. -- I couldn't really translate those.</p> <p>10 Q. And by saying you asked, you asked</p> <p>11 plaintiffs' counsel, and they provided you what they</p> <p>12 provided you, correct?</p> <p>13 MS. SCOTT: Objection.</p> <p>14 A. Yeah. So I want to use company</p> <p>15 documents, so give the company, essentially, as I</p> <p>16 believe I was supposed to do, so the company documents</p> <p>17 are -- I mean.</p> <p>18 BY MR. FROST:</p> <p>19 Q. Okay. And like we established before,</p> <p>20 you have no way of knowing if there are any other</p> <p>21 documents that just weren't given to you by plaintiffs'</p> <p>22 counsel, right?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 A. Well, I did. I did search -- I did</p> <p>25 search the Internet to try to find --</p>

<p style="text-align: right;">Page 186</p> <p>1 BY MR. FROST:</p> <p>2 Q. I'm talking about documents.</p> <p>3 A. The documents?</p> <p>4 Q. Yes. You have no way of knowing if what</p> <p>5 plaintiffs gave you is the complete set of documents</p> <p>6 that relate to the mine, right?</p> <p>7 A. I expected --</p> <p>8 MS. SCOTT: Objection.</p> <p>9 A. Yeah. Of all the documents that exist, I</p> <p>10 expect that it's not each and every single document.</p> <p>11 BY MR. FROST:</p> <p>12 Q. So you've made your review and your</p> <p>13 opinions on the China based on what is admittedly an</p> <p>14 incomplete set of documents provided to you by</p> <p>15 plaintiffs' counsel, right?</p> <p>16 MS. SCOTT: Object to the form.</p> <p>17 A. I don't know if it's fully -- I made</p> <p>18 requests for the China for as much -- all the</p> <p>19 information on China that there was and, to my</p> <p>20 knowledge, what was provided, and then what I looked at,</p> <p>21 I tried to search things on my own. There just is</p> <p>22 apparently not a lot I would consider. I would</p> <p>23 certainly consider reviewing documents on China. I</p> <p>24 would certainly consider translated documents, so</p> <p>25 someone who's got an expertise but --</p>	<p style="text-align: right;">Page 188</p> <p>1 metal contents like lead, cobalt, chromium, iron, nickel</p> <p>2 and titanium, correct?</p> <p>3 A. Correct.</p> <p>4 Q. And then you cite to JNJ 59273, right?</p> <p>5 A. Right.</p> <p>6 Q. Okay. Let's look at that document.</p> <p>7 A. It's got 750 parts per million of</p> <p>8 titanium in it. It's actually low. It's like .2.</p> <p>9 (Exhibit 18 was marked for</p> <p>10 identification.)</p> <p>11 BY MR. FROST:</p> <p>12 Q. I'll divert your attention to page 2086.</p> <p>13 I take it the comment at the bottom of 2086 is where</p> <p>14 you're getting this information from, right?</p> <p>15 MS. SCOTT: Objection.</p> <p>16 A. I looked at the data. Actually, I'm</p> <p>17 looking for the data table that I saw the other day.</p> <p>18 Yeah, so 2078, titanium 750. The lead there is 12.7 on</p> <p>19 the previous table. Let's look and see what the</p> <p>20 concentrations are.</p> <p>21 BY MR. FROST:</p> <p>22 Q. You're on 2078?</p> <p>23 A. I am on 2078.</p> <p>24 Q. Okay.</p> <p>25 A. And so --</p>
<p style="text-align: right;">Page 187</p> <p>1 BY MR. FROST:</p> <p>2 Q. Again, I'm trying to rein in your answers</p> <p>3 here --</p> <p>4 A. Okay.</p> <p>5 Q. -- to what we're talking about. But I</p> <p>6 want to be clear. The requests you made weren't to</p> <p>7 either Imerys or Johnson & Johnson. You made those</p> <p>8 requests to plaintiffs' counsel?</p> <p>9 A. Yes.</p> <p>10 Q. And then plaintiffs' counsel provided</p> <p>11 back to you a set of documents?</p> <p>12 A. Yes.</p> <p>13 Q. And you can't tell me whether or not that</p> <p>14 set consists of all documents that you requested related</p> <p>15 to the Chinese mines, right?</p> <p>16 MS. SCOTT: Objection.</p> <p>17 A. I cannot without certainty.</p> <p>18 BY MR. FROST:</p> <p>19 Q. All right. So let's look at what you</p> <p>20 opine. Page 11, the second paragraph, you state, as far</p> <p>21 back as 1983, and again, we know in 1983, Johnson &</p> <p>22 Johnson was not sourcing talc from China, right?</p> <p>23 A. Correct.</p> <p>24 Q. Defendants had information indicating</p> <p>25 that Chinese talc contains higher than normal heavy</p>	<p style="text-align: right;">Page 189</p> <p>1 Q. Do you see the top of 2078 that that</p> <p>2 chart relates to something called "Kwangsi No. 1 talc"?</p> <p>3 A. Yes.</p> <p>4 Q. Do you believe that Kwangsi No. 1 talc</p> <p>5 was the talc ever used by Johnson & Johnson?</p> <p>6 A. It's unclear. I don't.</p> <p>7 Q. Well, in your report, I think you note</p> <p>8 that they use Kwangsi No. 1 and Kwangsi No. 2, correct?</p> <p>9 A. Correct.</p> <p>10 MS. O'DELL: Objection.</p> <p>11 A. I think -- again, I'm not an expert in</p> <p>12 Chinese language.</p> <p>13 BY MR. FROST:</p> <p>14 Q. But you'd agree with me that Kwangsi No.</p> <p>15 1 is not Kwangsi talc, correct? It's a different ore?</p> <p>16 A. I don't really know. Names of mines</p> <p>17 change and things, but, potentially, they seem</p> <p>18 different. That's reasonable. But in my sentence, I</p> <p>19 say defense information indicating that Chinese talc</p> <p>20 contains higher than normal levels and, you know, the</p> <p>21 metals are there. So I think that statement is</p> <p>22 consistent with the chart on page 2078 and 2086, and</p> <p>23 let's look at -- it's been a while since I looked at the</p> <p>24 document.</p> <p>25 Q. Hold on. Let me walk you through it.</p>

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<p>1 A. I'd like to review --</p> <p>2 Q. Well, I want to talk about your</p> <p>3 statement, then. When you're saying Chinese talc is</p> <p>4 higher than normal --</p> <p>5 A. Can I?</p> <p>6 Q. No.</p> <p>7 MS. SCOTT: Let him ask the question.</p> <p>8 BY MR. FROST:</p> <p>9 Q. Can you answer my question, please?</p> <p>10 A. Okay. Good.</p> <p>11 Q. When you say Chinese talc contains higher</p> <p>12 than normal heavy metal contents, you're talking about</p> <p>13 all talc from China, not necessarily the Chinese talc</p> <p>14 that Johnson & Johnson was using? Is that what you're</p> <p>15 telling me?</p> <p>16 MS. SCOTT: Objection.</p> <p>17 A. I'm sorry.</p> <p>18 BY MR. FROST:</p> <p>19 Q. I'll ask you the question again, so you</p> <p>20 don't have to read it.</p> <p>21 A. Yeah.</p> <p>22 Q. So in your report, when you're talking</p> <p>23 about Chinese talc, you're talking about talc from the</p> <p>24 country of China, not the Chinese talc ore that Johnson</p> <p>25 & Johnson was using? Is that what you're telling us?</p>	<p>1 refer to this as an indication that there are</p> <p>2 problematic materials in Chinese ore. Obviously, it was</p> <p>3 investigated for a reason, so they were interested in it</p> <p>4 at some level.</p> <p>5 BY MR. FROST:</p> <p>6 Q. Okay. But you agree with me you have no</p> <p>7 way to tell us one way or the other that any of the</p> <p>8 tests of any of the ore in this document actually relate</p> <p>9 to the talcum powder that 20 years, 30 years later made</p> <p>10 it into Johnson & Johnson talcum powder products?</p> <p>11 MS. O'DELL: Objection.</p> <p>12 A. The -- the documentation provided to me</p> <p>13 is -- there's many gaps.</p> <p>14 BY MR. FROST:</p> <p>15 Q. Sir, I'm talking about this document.</p> <p>16 Focus on this document. So my question is: This</p> <p>17 document, is there anywhere in this document that says</p> <p>18 the talc that Johnson & Johnson uses 20 years later for</p> <p>19 talcum powder has constituents? I understand we're</p> <p>20 talking --</p> <p>21 A. Has constituents?</p> <p>22 Q. Has the constituents we're talking about</p> <p>23 here. You know, that "Defendant had information</p> <p>24 indicating that Chinese talc contains higher than normal</p> <p>25 heavy metal contents like lead, cobalt, chromium, nickel</p>
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<p>1 MS. SCOTT: Objection.</p> <p>2 A. I meant, essentially, both more Chinese,</p> <p>3 Chinese talc, meaning talc within the boundaries of</p> <p>4 China has more or has contaminants and would be of</p> <p>5 potential concern.</p> <p>6 BY MR. FROST:</p> <p>7 Q. That's a general statement as to all</p> <p>8 talcs coming out of all talc regions of China?</p> <p>9 MS. O'DELL: Object to the form.</p> <p>10 BY MR. FROST:</p> <p>11 A. Well, it's specific to this example, and</p> <p>12 as an example, I think there's, there's a lot of concern</p> <p>13 in the general environmental literature about materials</p> <p>14 in China in general so --</p> <p>15 Q. And by concerns over materials in</p> <p>16 general, you're talking about now everything coming out</p> <p>17 of China as a generalization?</p> <p>18 MS. SCOTT: Objection.</p> <p>19 A. Not everything.</p> <p>20 BY MR. FROST:</p> <p>21 Q. But you're talking about, like, the lead</p> <p>22 concerns out of manufactured products like toys, and</p> <p>23 we're including this now in your statement, right?</p> <p>24 MS. SCOTT: Objection.</p> <p>25 A. No. I'm sorry. Let me just be clear. I</p>	<p>1 and titanium." Is there anything in here --</p> <p>2 A. They simply knew that this is how I --</p> <p>3 they simply know that this report existed, right?</p> <p>4 Q. You have to listen to my question. You</p> <p>5 can't tell me one way or the other that this report in</p> <p>6 any way relates to any talc ever used by Johnson &</p> <p>7 Johnson for its talcum powder, right?</p> <p>8 MS. SCOTT: Objection.</p> <p>9 A. I do not have a chain of custody, so,</p> <p>10 yes.</p> <p>11 Q. Okay.</p> <p>12 A. But the way the sentence is phrased, the</p> <p>13 sentence is general.</p> <p>14 Q. Yes. We've established that now.</p> <p>15 MS. O'DELL: Excuse me.</p> <p>16 BY MR. FROST:</p> <p>17 Q. No, no. I'm saying --</p> <p>18 MS. O'DELL: You interrupted him -- let</p> <p>19 him finish.</p> <p>20 MR. FROST: Sure.</p> <p>21 BY MR. FROST:</p> <p>22 Q. In general --</p> <p>23 MS. O'DELL: Stop talking. Let him talk.</p> <p>24 Thank you.</p> <p>25 A. So the sentence is general. Defendants</p>

<p style="text-align: right;">Page 194</p> <p>1 have information indicating that Chinese talc contains 2 higher than normal levels of lead, cobalt, chromium. So 3 I feel that this document supports that statement. It 4 doesn't say all talc, but they had knowledge that 5 some -- 6 BY MR. FROST: 7 Q. Some talc? 8 A. -- talc had issues. 9 Q. Okay. 10 THE WITNESS: My thing is -- I think it 11 stopped. What time? It says 1520. 12 MS. SCOTT: Did you hit "follow"? 13 THE WITNESS: Yeah, I have hit "follow" 14 several times. 15 BY MR. FROST: 16 Q. All right. While they're sorting that 17 out, I'll continue to ask my questions. 18 A. Okay. 19 Q. All right. Page 11 of your report, 20 second full paragraph starts, "In the Guangxi Province." 21 A. Yes. 22 Q. If you look down the citation, you say, 23 after it, it says, "In "Talc Geology, Resources, 24 Production and Market Study, Guangxi Autonomous Region," 25 asbestos was discovered in fractures of the talc ore</p>	<p style="text-align: right;">Page 196</p> <p>1 deposits are geologically related, to the best of my 2 ability. Again, there is some paucity of data, but it 3 seemed, from what I could gather, that these are 4 geologically related. 5 BY MR. FROST: 6 Q. So sitting here today, you can tell me 7 that you've specifically looked at the Maanshan deposit 8 and the -- I apologize to the court reporter for these 9 names -- and Zhizhua Mine, and you're confident and you 10 can tell me that you have seen sources that shows those 11 two exact deposits are similar and come from the same 12 areas? And if that's true, what's your source? 13 A. Let me -- so... 14 MS. O'DELL: Objection. 15 A. So asbestos was discovered and fractures 16 of the talc ore body of the Maanshan deposit looking in 17 the Shanglin region. And the question is am I certain 18 that talc -- 19 BY MR. FROST: 20 Q. You just told me that you've seen 21 something that says Maanshan is the same geological 22 formation? 23 A. Can we look at 413792? 24 Q. I don't have it. Is that the one we just 25 looked at, though?</p>
<p style="text-align: right;">Page 195</p> <p>1 body of the Maanshan talc deposit located in the 2 Shanglin region." 3 Did I read that right, or close enough, 4 anyway, on the pronunciations? 5 A. Yes. 6 Q. Did Johnson & Johnson ever use talc from 7 the Maanshan deposit? 8 A. I'm not sure. I'm confused by that, the 9 Chinese words, so I'm not sure. But, again, there 10 was -- so I don't know for sure, but there was a paucity 11 of data relating to Chinese, I think. 12 Q. You specifically state, if you look back 13 at page 8 -- 14 A. I forget. 15 Q. -- of your report, you state, "2002 to 16 present: Zhizhua Mine, Guigang Province, China. 17 Product Name: Guangxi No. 2 and Guangxi No. 2A" 18 A. Yeah. Those are two. 19 Q. Maanshan is not the Guangxi mine that's 20 mentioned there, correct? 21 A. Correct. 22 Q. And you have no evidence that Johnson & 23 Johnson ever sourced talc from the Maanshan deposit? 24 MS. SCOTT: Objection. 25 A. Correct. But as I understand it, the</p>	<p style="text-align: right;">Page 197</p> <p>1 MS. SCOTT: No. 2 MR. FROST: A different one. I don't 3 have it, so, no. I mean, you guys can do it 4 during your time. 5 MS. O'DELL: If he wants to see the 6 document and it's available to him -- 7 All right. If he has it. 8 A. Can we? So it's Imerys 413792, Imerys. 9 VIDEOGRAPHER: Watch your mic. Doctor, 10 watch your mic. 11 A. That's 413792. 413792. It is a JNJ. 12 BY MR. FROST: 13 Q. No. It is an Imerys. 14 VIDEOGRAPHER: Do you want to go off the 15 record? 16 MR. FROST: Let's go off the record, 17 please. 18 VIDEOGRAPHER: We're now going off 19 record. The time is 3:32. 20 (Recess taken from 3:32 to 3:39.) 21 VIDEOGRAPHER: We're now back on record. 22 The time is 3:39. 23 BY MR. FROST: 24 Q. Okay. So do you believe this document 25 supports that the geology of Zhizhua and Maanshan are</p>

<p style="text-align: right;">Page 198</p> <p>1 the same?</p> <p>2 A. So Guangxi is an autonomous region.</p> <p>3 Q. Okay.</p> <p>4 A. And there are different mines within that</p> <p>5 autonomous region.</p> <p>6 Q. So, again, do you have anything that</p> <p>7 shows me that the formation at the Zhizhua Mine are the</p> <p>8 same as the Maanshan mine?</p> <p>9 A. No. I don't think so, or I'm unclear.</p> <p>10 I'm confused by the names.</p> <p>11 Q. All right. That's fine. Moving on on</p> <p>12 page 11, the paragraph that starts about halfway down</p> <p>13 the page, "Beginning in July of 2004."</p> <p>14 A. Uh-huh.</p> <p>15 Q. And then the next two paragraphs sort of</p> <p>16 preceding that, do you agree with me that these all</p> <p>17 relate to a mine visit in the Liboshikuang Mine of the</p> <p>18 Shandong Province?</p> <p>19 A. I'm confused by the names. I would need</p> <p>20 to look at the document.</p> <p>21 Q. Yeah. And Hubei and Shandong. Well,</p> <p>22 here. We'll start with the first paragraph. "Beginning</p> <p>23 in ... 2004, Rio Tinto began investigating talc</p> <p>24 operations and talc potential in the provinces of Hubei</p> <p>25 and Shandong." Did I read that correctly?</p>	<p style="text-align: right;">Page 200</p> <p>1 anything to refute that statement?</p> <p>2 MS. SCOTT: Objection.</p> <p>3 A. I have nothing to refute or endorse. I</p> <p>4 do know the geology of China is very chopped up. It's</p> <p>5 extremely complex. So you can have areas that are</p> <p>6 geologically connected that are distant from each other.</p> <p>7 So Tianchen is a basin area in north central China. I</p> <p>8 have colleagues that work there, and essentially, there</p> <p>9 are major displacements that occur.</p> <p>10 So, again, I didn't have details of</p> <p>11 China, but, essentially, China is very complex, and you</p> <p>12 can have parts of the geology disperse. Yes, I was not</p> <p>13 aware that they were separated by geographic distance.</p> <p>14 That doesn't preclude that.</p> <p>15 BY MR. FROST:</p> <p>16 Q. Well, I was going to say without</p> <p>17 speculating, your can't tell me whether or not the talc</p> <p>18 districts of Hubei and Shandong are the same as the talc</p> <p>19 district in Guangxi, for example, correct?</p> <p>20 MS. SCOTT: Objection.</p> <p>21 BY MR. FROST:</p> <p>22 Q. Sitting here today --</p> <p>23 A. Correct. But the statement as "Rio Tinto</p> <p>24 began investigating talc operations and talc potential</p> <p>25 in the provinces of Hubei and Shandong."</p>
<p style="text-align: right;">Page 199</p> <p>1 A. Yeah. So, to my knowledge, that</p> <p>2 paragraph is correct.</p> <p>3 Q. But I didn't ask if it was correct.</p> <p>4 A. Okay.</p> <p>5 Q. My question is: Do you agree with me</p> <p>6 that Hubei and Shandong are different areas of China</p> <p>7 than Guangxi?</p> <p>8 MS. SCOTT: Objection.</p> <p>9 A. I don't know.</p> <p>10 BY MR. FROST:</p> <p>11 Q. Okay. Did you ever look up Hubei and</p> <p>12 Shandong and compare them to where Guangxi sits?</p> <p>13 A. I don't remember. If I did, I -- you</p> <p>14 know, I got -- the nomenclature, the names were</p> <p>15 confusing. So I did -- I try to look at Google Earth</p> <p>16 and figure things out. But, again, I don't think there</p> <p>17 was, like, a location map that was provided. The data</p> <p>18 from China was very limited. There's no -- I don't</p> <p>19 think there's any GPS coordinates, which is another</p> <p>20 thing that's kind of odd. Okay. Go ahead.</p> <p>21 Q. If I were to represent to you that</p> <p>22 they're about 2,000 kilometers away from each other, the</p> <p>23 Hubei and Shandong are coastal by Shanghai and Guangxi</p> <p>24 is southern and internal and they're about</p> <p>25 2,000 kilometers away from each other, would you have</p>	<p style="text-align: right;">Page 201</p> <p>1 Q. Yes. Just answer my questions, okay?</p> <p>2 And, again, there's no evidence that talc ever came from</p> <p>3 Hubei and Shandong that was used in Johnson & Johnson</p> <p>4 talcum powder. You, sitting here today, without</p> <p>5 speculating, can't tell me that Johnson & Johnson ever</p> <p>6 used talc that came from Hubei and Shandong, correct?</p> <p>7 A. Correct.</p> <p>8 Q. And then it continues on, and it starts</p> <p>9 talking about the detailed visit to the Liboshikuang</p> <p>10 Mine in the Shandong province, correct? It's two</p> <p>11 paragraphs down. It talks about the field report and</p> <p>12 "the report detailed a visit?"</p> <p>13 A. The second paragraph on the bottom?</p> <p>14 Q. Yes.</p> <p>15 A. In Shandong? Okay.</p> <p>16 Q. Okay. And, again, it talks about a mine</p> <p>17 that you have no evidence whatsoever whether or not this</p> <p>18 has any geological similarity to the Shandong province</p> <p>19 or the Guangxi province, correct?</p> <p>20 MS. SCOTT: Objection.</p> <p>21 A. Specifically, no. There is no data that</p> <p>22 was --</p> <p>23 BY MR. FROST:</p> <p>24 Q. So what I'm getting at here is I'm a</p> <p>25 little confused why we're talking about talc districts</p>

<p style="text-align: right;">Page 202</p> <p>1 upon which you have no data that are thousands of 2 kilometers away from the mine actually being used by 3 Johnson & Johnson. 4 MS. SCOTT: Form. 5 A. Because just like in, as you pointed out 6 for the Appalachians, we have this very large district 7 that extends hundreds of kilometers. Based on the 8 limited data that was available to me, it's likely that, 9 essentially, talc deposits are genetically related in 10 some way. 11 BY MR. FROST: 12 Q. Except that didn't you just tell me 13 without speculating -- 14 MS. O'DELL: Excuse me. 15 MR. FROST: Old on. 16 MS. O'DELL: He was not finished. 17 A. So, basically, it's reasonable, you know, 18 so if you have -- you know, you have a deposit of 19 something, and you have similar deposits of that same 20 something, that it's reasonable that you would expect 21 there to be some connection or relationship. That's 22 something that we do in geology all the time, 23 essentially develop hypotheses as far as spatial 24 relationships of things. 25 So, basically, the fact that there's</p>	<p style="text-align: right;">Page 204</p> <p>1 MS. SCOTT: Objection. 2 BY MR. FROST: 3 Q. You don't know one way or the other; is 4 that correct? 5 MS. SCOTT: Objection. 6 MS. O'DELL: Objection. 7 A. With a hundred percent degree of 8 certainty, sure. But, geologically, it makes sense that 9 things would be related. 10 BY MR. FROST: 11 Q. Okay. And that's based on what studies 12 have you looked at in China that show you can make the 13 leap to say that these regions that you don't -- 14 A. That's -- 15 Q. Hold on -- that you don't know anything 16 about are related? 17 MS. SCOTT: Objection. 18 A. I base that on, essentially, just the 19 nature of tectonics on the planet. Essentially, there's 20 no peer review literature. 21 BY MR. FROST: 22 Q. Turn to page 12. It's the first full 23 paragraph. "I have reviewed multiple documents." It is 24 the paragraph that starts there. Do you see where I am? 25 A. Yes.</p>
<p style="text-align: right;">Page 203</p> <p>1 60 percent white talc and 40 percent black talc with the 2 latter having obvious tremolite association, so that's, 3 okay, one thing. And then, notably, it was associated 4 with amphibolite-grade metamorphism. Therefore, 5 Johnson & Johnson and Imerys had information regarding 6 tremolite's presence in the region. 7 And if you had indication of the presence 8 of something in the region, you know, you might exclude 9 that or you would want to do further exploration to sort 10 of constrain, as we mentioned earlier, with mining, we 11 want to define what's not there and what is there. 12 BY MR. FROST: 13 Q. But here's where I'm going stop you. All 14 of this concerns a region that's thousands of kilometers 15 away from the region that's actually being mined, right? 16 MS. SCOTT: Objection. 17 BY MR. FROST: 18 Q. So what does any of this actually have 19 anything to do, without speculating, about the talc 20 coming from the Zhizhua Mine in the Guangxi Province? 21 MS. SCOTT: Objection. 22 A. The geology can be potentially related. 23 BY MR. FROST: 24 Q. See, we're talking about can be here, but 25 you're speculating, right?</p>	<p style="text-align: right;">Page 205</p> <p>1 Q. Where is it? The third sentence. You 2 know that "The practices and procedures defendants' talc 3 fall short of satisfying international standards of 4 quality and purity." What international standards of 5 quality and purity are you talking about here that you 6 didn't cite? 7 A. So industrial mineral companies, 8 basically, we used the peer-review literature, and 9 essentially, things are developed internally to assure 10 that you have variability or control, and so it's 11 commonly done that you run multiple x-ray diffraction 12 analyses on materials, for example. So a company I work 13 closely with in Virginia, or have historically, they 14 analyze 200 samples a day, essentially, and they do that 15 with powder diffraction and, also, XRF. 16 There's analytical technologies that 17 exist that you can do rapid XRF analyses with a handheld 18 device, and that's been around since the early 2000s. 19 So, basically, the peer-review literature is one general 20 way of doing things. 21 Q. And then -- well, hold on. We'll start 22 there. What studies? Can you point me a single study 23 that talks about the international standards of quality 24 and purity that weren't met here? 25 MS. SCOTT: Objection.</p>

<p style="text-align: right;">Page 206</p> <p>1 A. So methods are communicated verbally in 2 industrial mineral companies. So, basically, by 3 interacting with companies, I know, basically, that you 4 analyze things repeatedly, repeatedly trying to 5 constrain the variability. Things aren't necessarily, 6 as far as what individual companies do, they look to the 7 peer-review literature to use or learn what analyses are 8 done and how they are executed.</p> <p>9 As far as the numbers of things, that's 10 something that's decided by companies, and basically, 11 using general statistical approaches, they want to know 12 what the variation is. So companies that I work with, 13 they commonly will analyze hundreds of, a couple hundred 14 samples a day or a week.</p> <p>15 Other companies I know, they have 16 dedicated labs that basically analyze hundreds of 17 thousands of samples a week, and it's expected that they 18 maintain that level because, eventually, they can get 19 sold or bought, so they want to be able to prove the 20 reserves and the historical thing. So that's -- that's 21 kind of the international standard is sort of multiple 22 things. It's by experience.</p> <p>23 Q. Here's what I want to get at. If I want 24 to know what the international standards of quality and 25 purity are, you're telling me there's not any document I</p>	<p style="text-align: right;">Page 208</p> <p>1 you if you want.</p> <p>2 A. Yeah. I need to look at it, but I think 3 that might be related to gold mining, but Gy is 4 something that's used in general.</p> <p>5 Q. Is Gy a universally adopted standard for 6 mining practices around the world?</p> <p>7 A. I think it's commonly used. Again, every 8 company has their own.</p> <p>9 Q. Why don't we look at Afewu, but, again, 10 you agree with me that Gy is one. There are probably 11 hundreds, if not thousands, of competing theories and 12 methodologies, right?</p> <p>13 MS. SCOTT: Objection.</p> <p>14 MS. O'DELL: Objection.</p> <p>15 A. I don't think that's an accurate 16 statement.</p> <p>17 BY MR. FROST:</p> <p>18 Q. But it's certainly not the only one, 19 right?</p> <p>20 A. Others exist.</p> <p>21 Q. So you can't tell me that Gy is the 22 universal standard for talc mining, right, and that 23 that's the standard that companies have to follow? 24 That's the, quote, international standard of quality and 25 purity?</p>
<p style="text-align: right;">Page 207</p> <p>1 can go to, any regulation or anything out there. I'm 2 trying to get the basis for your opinion here, and the 3 basis for your opinion here is Dr. Krekeler had told me 4 it's wrong and here's why, and you can't point to any 5 study --</p> <p>6 A. So --</p> <p>7 MS. O'DELL: Let him finish.</p> <p>8 THE WITNESS: Okay.</p> <p>9 BY MR. FROST:</p> <p>10 Q. -- regulation, mine document, anything 11 out there to support your basis. It's just I, Mark 12 Krekeler, am telling you this. You should believe me.</p> <p>13 MS. SCOTT: Objection.</p> <p>14 A. So Gy and the reference. Gy 79 is 15 something that's used sampling of particulate materials 16 there in practice.</p> <p>17 BY MR. FROST:</p> <p>18 Q. Let's talk about Gy. Gy is about gold 19 mining, right?</p> <p>20 A. Gy is about sampling of particulate 21 materials.</p> <p>22 Q. Related to gold mining, right?</p> <p>23 A. I don't recall specifically. Was it 24 Afewu? I believe the Afewu.</p> <p>25 Q. If you look at Afewu, I can mark that for</p>	<p style="text-align: right;">Page 209</p> <p>1 MS. SCOTT: Objection.</p> <p>2 A. I think it's relevant.</p> <p>3 BY MR. FROST:</p> <p>4 Q. We'll mark Afewu. We talked about Afewu.</p> <p>5 A. So if you're mining --</p> <p>6 Q. There's not a question pending, sir.</p> <p>7 A. Okay. Sorry.</p> <p>8 MS. O'DELL: This is 20?</p> <p>9 MR. FROST: 18.</p> <p>10 COURT REPORTER: 19.</p> <p>11 MR. FROST: 19?</p> <p>12 COURT REPORTER: Yes.</p> <p>13 (Exhibit 19 was marked for 14 identification.)</p> <p>15 BY MR. FROST:</p> <p>16 Q. On the first page, it's page 299 on the 17 first column. It's the paragraph that starts, "An 18 essential condition of any sample."</p> <p>19 A. Okay. I found the paragraph.</p> <p>20 Q. Okay. About halfway through, it starts 21 talking about the Gy paper. "A number of approaches 22 have been proposed to address these problems. The most 23 notable one is the work of Gy." Do you see where I am?</p> <p>24 A. Yes.</p> <p>25 Q. After that, it says, "Most practitioners</p>

<p style="text-align: right;">Page 210</p> <p>1 have used this model for gold ores, though, without much 2 fulfillment in the results." Am I reading that 3 correctly? 4 A. You're reading what they've said. 5 Q. Okay. 6 A. But, yeah. 7 Q. And you agree with me that there are laws 8 and regulations that relate to mining standards, how 9 mining has to be done, things of that nature, correct? 10 A. There are -- there's a code of mining 11 regulations. To my knowledge, there's not a specific 12 code as far as what's required for sampling. It's my 13 experience that, essentially, it's based on indications 14 from peer-reviewed literature, the concerns the company 15 has had as far as maintaining quality of their product, 16 so these are the standards that are set. Some companies 17 will have, essentially, internal protocols and standards 18 that are applied, and they're international companies, 19 so this is applied by international. 20 Q. So you don't believe there are any 21 regulations that relate to any miners that talk about 22 requirements of sampling? 23 MS. SCOTT: Objection. 24 A. At this point, I don't remember. I 25 don't --</p>	<p style="text-align: right;">Page 212</p> <p>1 Gy paper, and he talks about running Gy analysis of the 2 samples to determine whether or not they're 3 representative. Is that a fair sort of, really high 4 level synopsis of what he's talking about? 5 A. Yes. 6 Q. And in forming your opinions, I take it 7 you rely -- I mean, we've talked about Gy. You're 8 relying on the Gy theory, right? Is it a theory? I 9 don't know what the right word to call it is. Is it 10 mine theory? 11 A. It is an approach. 12 Q. Mine approach? 13 A. Yeah. It's very dense mathematically. 14 Q. I will agree with you there. And you're 15 effectively relying on the Gy approach in forming your 16 opinions about the mining sampling practices, correct? 17 A. It is one of them. It is one approach, 18 yes. 19 Q. And Afewu and Lewis is another one you 20 cite, too? 21 A. It's another example. 22 Q. And Afewu and Lewis also is another 23 mathematical geostatistical computation to determine 24 whether or not sampling is adequate and representative, 25 correct?</p>
<p style="text-align: right;">Page 211</p> <p>1 BY MR. FROST: 2 Q. "I don't know" is a fine answer, sir. 3 A. Yeah. I don't know with certainty. 4 Q. Okay. And I think we established this 5 morning, you're not a regulatory expert? You're not a 6 mine regulations expert? 7 A. Yeah. 8 Q. Okay. So at this point, you just don't 9 know. Have you ever heard of the organization JORC, 10 J-O-R-C? 11 A. What's that? 12 Q. JORC, J-O-R-C. I think it's the Joint 13 Regulatory Commission, something like that. 14 A. No, I have not. 15 Q. Do you recall seeing, in several of the 16 Imerys documents, that they were doing sampling to 17 various JORAC regulatory specifications? 18 A. No, I do not remember seeing that. 19 Q. And you have no idea what any of the 20 sampling regulations that they're applying for would be? 21 That's correct? 22 MS. O'DELL: Object to the form. 23 A. Yeah. I'm not familiar with that. 24 BY MR. FROST: 25 Q. While we're talking about Gy, I read the</p>	<p style="text-align: right;">Page 213</p> <p>1 A. Yes. That's another approach. 2 Q. Have you actually run any of the 3 geostatistical calculations in this case to determine 4 whether or not the sampling that was being done by 5 Imerys and Johnson & Johnson is adequate? 6 MS. SCOTT: Objection. 7 A. No, I have not. But I do note that I did 8 not see evidence of it either. 9 MR. FROST: Move to strike. No question 10 was pending. 11 BY MR. FROST: 12 Q. While we're on mining, let's talk about 13 it a little bit. Do you agree with me that mining 14 companies do not mill -- sorry. Let me try again. I 15 used the wrong word. Do you agree with me that mining 16 companies do not drill the entire deposit all at once? 17 MS. O'DELL: Object to the form. Do you 18 mean -- 19 BY MR. FROST: 20 Q. When they're doing core sampling? 21 A. They will -- it depends. So if there's 22 field indications that things are looking good and they 23 want to establish things, then there would be a reason 24 to drill the entire deposit if it's small. But, yeah, 25 if you have a large deposit, you would drill that in</p>

<p style="text-align: right;">Page 214</p> <p>1 phases.</p> <p>2 Q. And you'd sort of do it as the mine</p> <p>3 develops, right, as the -- as you're following the</p> <p>4 deposit? You -- a really untechnical way of saying it</p> <p>5 is, effectively, you're drilling ahead of where you are</p> <p>6 so you know where you can keep going, right?</p> <p>7 MS. SCOTT: Objection.</p> <p>8 A. It -- sometimes it's more complex than</p> <p>9 that. So, basically, people gain investment for</p> <p>10 exploration and it's -- you know, the investors are set</p> <p>11 on doing things one particular way because of what they</p> <p>12 believe. So there's variation in that.</p> <p>13 Q. Okay. And you agree that additional --</p> <p>14 you know, one of the reasons you do additional coring,</p> <p>15 additional drilling, is to further refine the mine plan,</p> <p>16 the mine schedule, things like that?</p> <p>17 A. Yes. So, often, coring will be done</p> <p>18 every day in certain situations. So that's the case in</p> <p>19 some palygorskite deposits in Georgia, and that's also</p> <p>20 the case in Brown Mountain Mine and other, other</p> <p>21 situations, yes. They'll drill daily and produce lots</p> <p>22 of core.</p> <p>23 Q. And, ultimately, mine operators are</p> <p>24 drilling a mine site in order to determine what the ore</p> <p>25 body itself actually looks like, right?</p>	<p style="text-align: right;">Page 216</p> <p>1 factor is the scale of the geologic features that are</p> <p>2 involved in the deposit. So, generally, you want to</p> <p>3 have a core density such that you can capture those</p> <p>4 scales of features.</p> <p>5 Q. And that's ore deposit -- by "ore</p> <p>6 deposit," depending, right, what you have to do to</p> <p>7 capture those features? Effectively, every mine is</p> <p>8 different; is that a fair synopsis?</p> <p>9 MS. SCOTT: Objection.</p> <p>10 A. The -- it depends on the local geology,</p> <p>11 but it still must be representative based on the</p> <p>12 features you're trying to capture.</p> <p>13 BY MR. FROST:</p> <p>14 Q. Okay. I think we're saying the same</p> <p>15 thing. You're just adding a lot more words, right?</p> <p>16 A. Okay.</p> <p>17 Q. But it depends on the local geology what</p> <p>18 the deposit looks like because every deposit is</p> <p>19 different, right?</p> <p>20 MS. SCOTT: Objection.</p> <p>21 A. You can have similar deposits, but, yeah,</p> <p>22 every deposit is in a different location.</p> <p>23 BY MR. FROST:</p> <p>24 Q. Sure. And there are different shapes and</p> <p>25 sizes, right?</p>
<p style="text-align: right;">Page 215</p> <p>1 A. As well as other areas of concern. So I</p> <p>2 gave the example on the Stebbins Hill for Brown</p> <p>3 Mountain. And they, you know, they have extensive</p> <p>4 amounts of core. They filled an entire high school,</p> <p>5 abandoned high school, with core.</p> <p>6 Q. Where you mine -- or sorry. Where you</p> <p>7 drill, when you drill, what angle you're drilling at, et</p> <p>8 cetera, all these are very complicated. You know, in a</p> <p>9 complicated ore body, where you drill, when you drill,</p> <p>10 the angles you drill at, these are all dictated by lots</p> <p>11 of factors, including topography, access to certain</p> <p>12 areas, things of that nature. Do you agree with that</p> <p>13 statement?</p> <p>14 MS. O'DELL: Objection.</p> <p>15 A. Not necessarily. You may -- people want</p> <p>16 to essentially have a good, even distribution so they</p> <p>17 try to drill on a grid, you know, if possible.</p> <p>18 BY MR. FROST:</p> <p>19 Q. Okay. As you said, not necessarily. It</p> <p>20 all depends, sort of, what you're seeing and what you're</p> <p>21 looking for, correct? There's no one way to drill core</p> <p>22 and ore body, right?</p> <p>23 A. There's multiple ways, but, you know,</p> <p>24 using -- essentially having something that is</p> <p>25 representative is reasonable. And one determining</p>	<p style="text-align: right;">Page 217</p> <p>1 A. Yes.</p> <p>2 Q. So because of that, you have to drill</p> <p>3 appropriate to the deposit that you're coring, correct?</p> <p>4 A. Yes.</p> <p>5 Q. And that's a determination that's usually</p> <p>6 made by the on-site geologist or by the company that's</p> <p>7 mining. You know, hopefully, they're consulting with</p> <p>8 somebody who understands the geology to determine where</p> <p>9 to drill. Is that also a fair statement?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. Ultimately, the company is responsible</p> <p>12 for how it drills, yes.</p> <p>13 BY MR. FROST:</p> <p>14 Q. Okay. Turn back to page 12 of your</p> <p>15 report. It's the third paragraph. You note that, "The</p> <p>16 practice of hand sorting is not acceptable in the United</p> <p>17 States." Do you have any law or regulation that you're</p> <p>18 pointing to that says that's inappropriate?</p> <p>19 MS. SCOTT: Objection.</p> <p>20 A. No. But, you know, the companies I work</p> <p>21 with wouldn't do that with something of this complexity.</p> <p>22 BY MR. FROST:</p> <p>23 Q. And you've never worked with talc before,</p> <p>24 right? You've never worked with a company that mines</p> <p>25 talc?</p>

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<p>1 A. Correct.</p> <p>2 Q. Okay. The next paragraph down, the -- I</p> <p>3 believe this is an email. Maybe I'll just mark the</p> <p>4 document. It might be easier.</p> <p>5 MR. FROST: We'll mark this one. I think</p> <p>6 we're on 20.</p> <p>7 COURT REPORTER: 20.</p> <p>8 (Exhibit 20 was marked for</p> <p>9 identification.)</p> <p>10 BY MR. FROST:</p> <p>11 Q. Do you see where you are in your report</p> <p>12 on page 12?</p> <p>13 A. I'm checking to see. I'll go back.</p> <p>14 Q. Sorry.</p> <p>15 A. Go back to 12. So 517. Okay.</p> <p>16 Q. And this is -- you're quoting here from</p> <p>17 an email --</p> <p>18 A Okay.</p> <p>19 Q -- from Mr. Cutler? Do you see where we</p> <p>20 are?</p> <p>21 A. Yes.</p> <p>22 Q. Okay. So you quote a portion of this</p> <p>23 email from Mr. Cutler, right? And then the next</p> <p>24 paragraph down, you go, "Cutler goes on to say, 'In</p> <p>25 principle, the inspection is enough to guarantee the</p>	<p>1 bottom of 5147 -- I'll go two lines up. I'll start</p> <p>2 there. There's some stuff above it, but it starts,</p> <p>3 "During unloading, a representative industrial sample</p> <p>4 (at least 25mt) is processed in the plant at various</p> <p>5 meshes and sent to our central Denver lab to be analyzed</p> <p>6 for main specs (whiteness, mineralogy, chemical</p> <p>7 composition, major elements and traces). Fibers</p> <p>8 investigation is carried out systematically. The lot is</p> <p>9 quarantined, waiting the lab results." Don't you agree</p> <p>10 with me that's the most important piece of what Cutler</p> <p>11 is saying there --</p> <p>12 MS. SCOTT: Objection.</p> <p>13 BY MR. FROST:</p> <p>14 Q. -- for purposes of your opinion that it</p> <p>15 does not guarantee the absence of fibers or asbestos and</p> <p>16 fibrous talc?</p> <p>17 MS. SCOTT: Objection.</p> <p>18 A. So when the cargo arrives at destination,</p> <p>19 so that's after it's been hand picked, right?</p> <p>20 BY MR. FROST:</p> <p>21 Q. Sure. What I'm saying here is: You use</p> <p>22 the quote you have above as a basis for your --</p> <p>23 A. So they're not -- I'm stating --</p> <p>24 Q. Let me finish, sir.</p> <p>25 A. Okay. I'm sorry. Sorry.</p>
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<p>1 requested specs to insure no fibers.'" And then, after</p> <p>2 that, you make the opinion, "That practice falls below</p> <p>3 the standards of quality control in mining operations in</p> <p>4 the United States, and it does not guarantee the absence</p> <p>5 of fibers, such as asbestos or fibrous talc." Did I</p> <p>6 read that correctly?</p> <p>7 A. Yes.</p> <p>8 Q. Okay. If you look up at the quote from</p> <p>9 Mr. Cutler's email and if you turn to the email itself,</p> <p>10 it's the bottom of page 5147. This is not a complete</p> <p>11 quote from Mr. Cutler's email, correct?</p> <p>12 MS. SCOTT: Objection.</p> <p>13 A. Let me find -- so where is it on 5147?</p> <p>14 BY MR. FROST:</p> <p>15 Q. It's at the bottom.</p> <p>16 MS. SCOTT: It's in B.</p> <p>17 BY MR. FROST:</p> <p>18 Q. Yeah, it's in B.</p> <p>19 A. So "In principle, this inspection is</p> <p>20 enough to guarantee the requested specs and insure no</p> <p>21 fibers."</p> <p>22 Q. Okay. But do you see above that your</p> <p>23 block quote? So what I find interesting is the part you</p> <p>24 left out of Mr. Cutler's email is actually the part that</p> <p>25 talks about the testing for fibers. If you look at the</p>	<p>1 Q. So you use the quote above here as the</p> <p>2 basis for your statement that the practice falls below</p> <p>3 the standards of quality in mine operations in the</p> <p>4 United States and does not guarantee the absence of</p> <p>5 fibers such as asbestos and fibrous talc, but left out</p> <p>6 of the quote you're taking from the email is the</p> <p>7 specific part of the testing that talks about the</p> <p>8 testing for fibers in the talc. Am I correct or</p> <p>9 incorrect?</p> <p>10 A. I did not include that portion in the</p> <p>11 quote.</p> <p>12 Q. Okay. Let's move on.</p> <p>13 A. I --</p> <p>14 Q. All right. Moving on.</p> <p>15 A Okay.</p> <p>16 MS. SCOTT: If he's not done with his</p> <p>17 answer, let him finish his answer.</p> <p>18 A. But, yeah, I'm not. So it is -- you</p> <p>19 know, if you're mining material and then you have a</p> <p>20 point of shipment, you would want to test that at that</p> <p>21 point of shipment in case you find something later. You</p> <p>22 would be able to identify where in the supply chain an</p> <p>23 issue occurred. So is this -- you know, is this shipped</p> <p>24 by a ship, correct? Right? So multiple things can be</p> <p>25 put into a ship cargo. You can have a whole crate of</p>

<p>Page 222</p> <p>1 asbestos, you know, from Indiana or Russia or some other 2 place or some other material that is mixed in. So, to 3 me, it really does make sense that at the stage of when 4 it leaves the port, you would want to have some quality 5 control so -- 6 BY MR. FROST: 7 Q. Here's my question. Isn't that exactly 8 the part that you left out of the quote? Isn't it 9 disingenuous that you left out the fibrous talc? 10 A. As I read it, as I read it -- 11 MS. O'DELL: Dr. Krekeler, he's not done. 12 A. Oh, I'm sorry. Sorry. 13 BY MR. FROST: 14 Q. Don't you agree with me that it's 15 disingenuous to leave out the specific portion of the 16 quote that talks about the testing that's done once the 17 talc arrives at port in Houston when you're making, 18 based on that quote, the opinion that it does not 19 guarantee the absence of fibers and falls short? 20 MS. SCOTT: Objection. Misrepresents. 21 A. Yeah. I say it's in the report for the 22 reasons I provided. 23 BY MR. FROST: 24 Q. Okay. All right. Let's move on. 25 MR. FROST: Actually, if you want, I</p>	<p>Page 224</p> <p>1 A. Yes. 2 Q. Okay. What is the basis that grinding 3 the sample before testing will make it much more 4 difficult to -- 5 A. So talc is a phyllosilicate mineral. 6 It's a two-to-one layer clay. Essentially, the 7 structure is held together by long hydrogen bonds and it 8 is mechanically very soft. So, basically, 9 phyllosilicates have essentially delicate structures and 10 they need to be prepared in specific ways so grinding is 11 a rotary motion and what that does is -- the crystal 12 structure is shown here for talc. 13 So what that does is it takes these 14 two-to-one layers. When you grind, you displace, you 15 know, essentially, a rotation of the crystal structure, 16 and that rotation of the crystal structure basically 17 destroys the crystallographic coherency through the clay 18 particle. So if you are -- essentially, for x-ray 19 analysis, you're supposed to crush materials. So crush 20 is specifically an up-and-down motion. And, basically, 21 it's easy to do with talc. You crush it in this 22 up-and-down motion, typically in an agate mortar and 23 pestle. 24 And then so, basically, what happens is 25 you also have other potential contaminants such as</p>
<p>Page 223</p> <p>1 don't know how long we've been going. This is 2 probably a good time for a break. I'm changing 3 subjects. 4 MS. SCOTT: Sure. Great. 5 VIDEOGRAPHER: We are now going off 6 record. The time is 4:12. 7 (A recess was taken from 4:12 to 4:38.) 8 VIDEOGRAPHER: We're now back on record, 9 and the time is 4:38. 10 BY MR. FROST: 11 Q. I'm going to move back to page 12 -- 12 A. Okay. 13 Q. -- of your report. The last full 14 paragraph on page 12, sir, it's a document entitled 15 "Quality Control." 16 A. Okay. 17 Q. Okay. And you note, "This document 18 includes procedures related to Guangxi Number 1 and 19 Number 2A, the talc ore purchased by Defendants for use 20 in Johnson's Baby Powder and Shower to Shower products. 21 Again, the procedure calls for samples to be ground 22 prior to testing a protocol that will disrupt the 23 physical properties of the talc ore, making detection of 24 harmful contaminants, including asbestos, much more 25 difficult." Did I read that right?</p>	<p>Page 225</p> <p>1 chrysotile. Chrysotile is a one-to-one layer 2 serpentine. It is coiled because the octahedral sheet 3 and the tetrahedral sheet don't match up. So there's 4 other serpentines such as antigorite, lizardite, 5 crocidolites, other things like that. 6 So what needs to happen is, again, that 7 needs to be prepared in a crush method, not a rotary, 8 not ground. So grinding -- ground, grinding -- those 9 words have specific meanings in the context of 10 phyllosilicates. It's been well, recognized, and I 11 provide several references elsewhere in the report. 12 So essentially what happens is x-ray 13 diffraction has detection limits, and for many 14 materials, such as quartz, that are very crystalline, 15 your detection limit is approximately about a tenth of a 16 weight percent, and that's generally understood. That's 17 a long-standing detection limit. 18 Clay minerals, in general, the 19 phyllosilicates, in general, those materials typically 20 have a detection limit that is at least a few weight 21 percent, in part because they start off as essentially 22 poorly crystalline material. So if you take a talc or a 23 chlorite and you compare that to another, you know, a 24 mineral such as a pyroxene, the overall crystallinity of 25 the pyroxene is much, much more than the talc or the</p>

<p style="text-align: right;">Page 226</p> <p>1 chlorite. So and then there's also many issues with --</p> <p>2 the minerals are just very sensitive, and they naturally</p> <p>3 have disorder.</p> <p>4 For example, chlorite theoretically can</p> <p>5 have 1,024 different arrangements of the layers of atoms</p> <p>6 in the structure, two-layer structure. So, basically,</p> <p>7 the crushing and grinding, you can grind -- if you have,</p> <p>8 let's say you have 4 percent chrysotile and 96 percent</p> <p>9 talc and you have that sample and you grind it, and</p> <p>10 essentially, you are destroying the crystal structures</p> <p>11 of both, and you only have, essentially, a 1 percent or</p> <p>12 so that is still crystalline or maybe none of it is</p> <p>13 crystalline.</p> <p>14 You can grind, actually do experiments</p> <p>15 and grind things to be amorphous. We did this when I</p> <p>16 was a Ph.D. student. He had us hammer home the point.</p> <p>17 But, basically, so the net effect is is when you grind</p> <p>18 stuff, you deflate the detection limit of materials that</p> <p>19 are there.</p> <p>20 It's already a problem -- you know,</p> <p>21 chrysotile is already problematic because, essentially,</p> <p>22 the shape of it. So it's a difficult material to work</p> <p>23 with. When you grind those materials, you will end up</p> <p>24 with, essentially, stuff that won't diffract. So,</p> <p>25 therefore, with powder x-ray diffraction, you cannot be</p>	<p style="text-align: right;">Page 228</p> <p>1 crush and smear, correct?</p> <p>2 MS. O'DELL: Objection.</p> <p>3 A They would be far less -- I think the</p> <p>4 proper thing to say is they would be far less</p> <p>5 susceptible to reduction and crystallinity, but, yeah,</p> <p>6 the chrysotile would be.</p> <p>7 BY MR. FROST:</p> <p>8 Q Okay. But, again, chrysotile is not --</p> <p>9 because of the closeness to talc, XRD is not the primary</p> <p>10 way of identifying chrysotile, correct?</p> <p>11 A. Oh, no.</p> <p>12 Q. I'm talking about specific to talc here.</p> <p>13 A. Were -- I'm sorry, was the question can</p> <p>14 you -- the difference --</p> <p>15 Q. Not can you, no.</p> <p>16 A. -- between talc and chrysotile?</p> <p>17 Q. Okay. Let me ask it another way. In the</p> <p>18 testing that is done of talc to determine whether or not</p> <p>19 there is asbestos, the way -- the test for chrysotile,</p> <p>20 you'll agree with me, is PLM, correct?</p> <p>21 A. I understand that powder x-ray</p> <p>22 diffraction is the primary screen.</p> <p>23 Q. That's the first screen, correct?</p> <p>24 A. Yes.</p> <p>25 Q. Okay.</p>
<p style="text-align: right;">Page 227</p> <p>1 assured that what you're measuring that you detect. So</p> <p>2 that's the issue with grounding.</p> <p>3 Q. Okay. So let me start here. Amphibiles</p> <p>4 aren't phyllosilicates, correct, amphibole minerals?</p> <p>5 MS. O'DELL: Amphiboles.</p> <p>6 BY MR. FROST:</p> <p>7 Q. Or amphiboles.</p> <p>8 A. They're part of the biopyriboles.</p> <p>9 Q Okay.</p> <p>10 A So but they are not a --</p> <p>11 Q. It's not phyllosilicate, correct?</p> <p>12 A. Correct.</p> <p>13 Q. And, again, the point of XRD, the</p> <p>14 testing, is to determine whether or not there are</p> <p>15 amphibole particles in the talc. Is that also correct?</p> <p>16 MS. SCOTT: Objection.</p> <p>17 A. Yes.</p> <p>18 BY MR. FROST:</p> <p>19 Q. Okay. So what you're talking about here</p> <p>20 is we'd ruin the talc and it would be hard, but we don't</p> <p>21 care because we know talc is in there. What we're</p> <p>22 looking for are amphiboles, right? So crushing isn't</p> <p>23 going to be a problem with identifying the amphiboles,</p> <p>24 because they aren't subject to smear and amorphousness,</p> <p>25 if that's the right word, but becoming amorphous through</p>	<p style="text-align: right;">Page 229</p> <p>1 A. And then if -- then if there's something</p> <p>2 that's detected, it then goes to PLM. And then if is</p> <p>3 something is detected, it goes to TEM. So if you</p> <p>4 don't -- if you're not -- if you're having, essentially,</p> <p>5 a false negative because you've ground away the</p> <p>6 chrysotile, you would not -- you know, as things were</p> <p>7 described, you wouldn't go on to the other techniques,</p> <p>8 but you would potentially have tremolite.</p> <p>9 Q. Yes. And you're actually going -- again,</p> <p>10 you've looked at Longo's testing, right?</p> <p>11 A. Yes.</p> <p>12 Q. So would you invalidate Longo's testing</p> <p>13 because he crushes and grinds the samples before putting</p> <p>14 them through his various tests, including XRD?</p> <p>15 MS. O'DELL: Objection.</p> <p>16 A. I -- there might be some differences, but</p> <p>17 overall, my review of Longo's report, I think it's fine.</p> <p>18 BY MR. FROST:</p> <p>19 Q. Okay. And, again, in looking through</p> <p>20 Longo's report, despite that he crushed and smeared, did</p> <p>21 he come up with any amorphous -- you know, did he</p> <p>22 identify any amorphous figures within the talc?</p> <p>23 MS. SCOTT: Objection.</p> <p>24 MS. O'DELL: Object to form.</p> <p>25 A. I don't remember specific. I remember</p>

<p style="text-align: right;">Page 230</p> <p>1 seeing lots and lots of TEM images by -- there's a lot 2 of TEM images. I don't remember specifically. 3 BY MR. FROST: 4 Q. You also agree with me that the amphibole 5 content that you're looking for in baby powder is 6 actually very small. We're talking about the micron 7 level, correct? 8 MS. O'DELL: Object to the form. 9 A. I'm sorry. What? 10 BY MR. FROST: 11 Q. We're talking about particles that are 12 measured by microns, not -- 13 A. For? 14 Q. -- inches or centimeters for the -- 15 A. For what context? 16 Q. The amphiboles -- 17 A. The amphiboles? 18 Q. -- that would be located in ground talcum 19 powder. 20 A. I'm sorry. I'm unclear on the question. 21 Can I -- 22 Q. I'll just ask it again. 23 A. Well, I would prefer to read, if that's 24 okay. 25 Q. Well, I'd prefer to reask you the, ask</p>	<p style="text-align: right;">Page 232</p> <p>1 or done by anybody else, have you ever seen any problem 2 with either smear or amorphous? 3 MS. SCOTT: Object to the form. 4 A. Yeah. By the nature of the test, as it's 5 been described, you know, you can't, you can't see -- I 6 want to say you can't see something that is not, that 7 you can't detect. So amorphous material doesn't 8 diffract x-rays. So x-rays arise when we have coherent 9 crystallinity that occurs. And then I'm trying to -- 10 BY MR. FROST: 11 Q. I understand, but let me stop you there. 12 You would see amorphous on TEM or SEM, wouldn't you, 13 when you were looking at images of the talc after it's 14 been prepared for a sample? 15 MS. O'DELL: Objection. 16 A. The -- only if you're, only if you're 17 looking for it. So you need to have electron 18 diffraction data that -- you said if you're only looking 19 for the asbestos materials so you're looking for 20 crystalline materials. You would not necessarily be 21 looking for amorphous. So I don't think Longo was 22 tasked with finding amorphous, amorphous 23 phyllosilicates. I think he -- 24 BY MR. FROST: 25 Q. But I'm confused. Doesn't Longo</p>
<p style="text-align: right;">Page 231</p> <p>1 you a different question, sir. 2 A. Okay. All right. Good. 3 MS. O'DELL: He can ask a different 4 question. 5 BY MR. FROST: 6 Q. So, again, my question is: The 7 amphiboles that we care about here, the ones we're 8 finding in the testing of talcum powder, are in microns 9 of size. They're tiny, correct? 10 A. They can be, yes. 11 Q. Okay. And because they're so small and 12 small by volume, grinding and crushing really isn't a 13 problem because you're not going to affect the 14 crystalline structure of something that small when you 15 grind it. Do you also agree with that? 16 MS. SCOTT: Objection. 17 A. Not necessarily. It depends on the 18 specific methods of grinding. 19 BY MR. FROST: 20 Q. And have you seen any evidence in any of 21 the testing that you've looked at in this case that 22 grinding and crushing has caused a problem with smear or 23 amorphous -- I guess it would become an amorphous 24 particle. I don't know what the right second term would 25 be. But in any of the testing you've seen done by Longo</p>	<p style="text-align: right;">Page 233</p> <p>1 categorize every particle that was on the TEM grids? 2 MS. O'DELL: Objection. In what way? 3 MR. FROST: He accounts for them on his 4 count sheets. 5 BY MR. FROST: 6 Q. If you don't know, sir, that's fine, too. 7 A. I don't remember. 8 Q. Okay. That's fine. We'll move on. 9 Now, sir, are you aware that talcum 10 powder, cosmetic talcum powder specifically is regulated 11 by the FDA? 12 MS. SCOTT: Objection. 13 A. I know they have looked at it. I don't 14 know if they've -- I'm not a regulatory expert. So I 15 just know that they've looked at it. I don't know that 16 there's a study on talc. 17 BY MR. FROST: 18 Q. I'm not talking about regulations, 19 regulations and testings -- 20 A. Oh, okay. I'm sorry. Yeah. No. 21 Q. Okay. All right. Are you aware that 22 there is an FDA sanction testing model called J4-1? 23 A. No, I'm not. 24 Q. Okay. And you don't know whether or not 25 the companies are using J4-1 to test their product</p>

<p style="text-align: right;">Page 234</p> <p>1 because that's what's required of them?</p> <p>2 MS. O'DELL: Object to form.</p> <p>3 MS. SCOTT: Object to the form.</p> <p>4 A. No.</p> <p>5 BY MR. FROST:</p> <p>6 Q. Okay. Sir, do you agree with me that</p> <p>7 compliance with legal standards is an important</p> <p>8 consideration in determining if a mine is being operated</p> <p>9 correctly?</p> <p>10 MS. SCOTT: Objection.</p> <p>11 A. Yes, in general.</p> <p>12 BY MR. FROST:</p> <p>13 Q. And as we said before, you just don't</p> <p>14 know one way or the other whether or not -- well, I</p> <p>15 guess, what regulations govern these talc mines and</p> <p>16 whether or not the companies were abiding by those</p> <p>17 regulations. Is that fair?</p> <p>18 MS. SCOTT: Object to the form.</p> <p>19 BY MR. FROST:</p> <p>20 Q That's not your area of expertise?</p> <p>21 A. Yeah. I'm not a regulatory expert.</p> <p>22 Q. Turn to page 39, I believe, of your</p> <p>23 report. One, two, third paragraph down, it says,</p> <p>24 "Examination of data from several mines."</p> <p>25 A. On page 39. "Examination of data from</p>	<p style="text-align: right;">Page 236</p> <p>1 for that statement, correct?</p> <p>2 A. Yes.</p> <p>3 Q. So we'll start at the first cite, which</p> <p>4 is Furtron or Furcron, F-u-r-c-r-o-n, and others, 1947,</p> <p>5 deposits of Murray -- talc deposits in Murray County,</p> <p>6 Georgia, Georgia State Division of Conservation</p> <p>7 Department of Mines, Mineralogy, Mining and Geology?</p> <p>8 A. Uh-huh.</p> <p>9 Q. Okay. You agree with me that they're</p> <p>10 looking at Georgia mine formations, correct?</p> <p>11 A. Yes.</p> <p>12 Q. And that would -- they'd have nothing --</p> <p>13 no opinions or no specifics of what the actual ore body</p> <p>14 in Vermont looks like or Italy or China, correct?</p> <p>15 MS. SCOTT: Objection.</p> <p>16 A. Correct.</p> <p>17 BY MR. FROST:</p> <p>18 Q. Okay. The second citation here is Berg</p> <p>19 1977, and I think that was the one we identified earlier</p> <p>20 that was a mis-cite?</p> <p>21 A. Yes. I think it relates to Montana.</p> <p>22 Q. All right. Tab -- the next one is</p> <p>23 Mark -- where is it? Sandrone and Zucchetti?</p> <p>24 A. So --</p> <p>25 (Exhibit 21 was marked for</p>
<p style="text-align: right;">Page 235</p> <p>1 several mines," that paragraph?</p> <p>2 Q. Yes, that paragraph. Let me just orient</p> <p>3 myself. I apologize.</p> <p>4 All right. You note here, "Examination</p> <p>5 of data from several mines shows that ore bodies are</p> <p>6 very complex, with mixtures of several rock types,</p> <p>7 including those likely to have the presence of asbestos</p> <p>8 and heavy metals. These rock types are intimately mixed</p> <p>9 with talc ore. The variation of the bodies of rock</p> <p>10 differs and significant features may be only one foot</p> <p>11 thick or less." Correct?</p> <p>12 A. Yes. That is what it says.</p> <p>13 Q. Are you talking about the features there</p> <p>14 of the talc ore itself or are you talking about the</p> <p>15 other minerals that might be in the geological</p> <p>16 formation?</p> <p>17 A. So I'm talking about the ore as a whole,</p> <p>18 including, you know, lithologies that are rich in talc</p> <p>19 and not as well as the minerals and all the constituents</p> <p>20 of ore.</p> <p>21 Q. So you're talking about the ore body? I</p> <p>22 just want to clarify what we're talking about there.</p> <p>23 All right.</p> <p>24 A. Yes.</p> <p>25 Q. And that's Footnote 36, is the support</p>	<p style="text-align: right;">Page 237</p> <p>1 identification.)</p> <p>2 BY MR. FROST:</p> <p>3 Q. So it seems like this is talking about</p> <p>4 the Italian deposit.</p> <p>5 A. Yes. So, yeah.</p> <p>6 Q. You go one, two, three, four.</p> <p>7 MR. FROST: Oh, I apologize I thought he</p> <p>8 had the paper in front of him.</p> <p>9 COURT REPORTER: No.</p> <p>10 MR. FROST: Oh, I'm sorry.</p> <p>11 BY MR. FROST:</p> <p>12 Q. I'll reask the question. She didn't get</p> <p>13 it.</p> <p>14 So the question was: This paper appears</p> <p>15 to be dealing with the Italian mines, correct, the</p> <p>16 Italian deposit?</p> <p>17 A. Yes. Can I state a clarification?</p> <p>18 Q. Sure.</p> <p>19 A. So this is actually meant as an</p> <p>20 introduction paragraph. So several mines, meaning</p> <p>21 several mines of talc, in general.</p> <p>22 Q. Okay.</p> <p>23 A. So that sentence does not specifically</p> <p>24 relate to -- as written doesn't necessarily relate to</p> <p>25 mines in Vermont but just in general.</p>

<p style="text-align: right;">Page 238</p> <p>1 Q. Okay.</p> <p>2 A. So --</p> <p>3 Q. So it's not a statement --</p> <p>4 A. The thing that's gone, the Berg paper</p> <p>5 shows really intimate associations of, you know,</p> <p>6 small-scale features. So it's meant to be general.</p> <p>7 Sorry.</p> <p>8 Q. Okay. So these aren't talking about any</p> <p>9 of the mines that we're specifically talking about here:</p> <p>10 The Vermont mines, the Italian mine and the Chinese</p> <p>11 mines, the ones at issue on page 7 and 8 --</p> <p>12 A. That sentence does --</p> <p>13 Q -- of your report?</p> <p>14 A -- not refer to those, yes.</p> <p>15 Q Turn to page 41 of your report, please.</p> <p>16 The very -- the sentence that goes from 41 to 42.</p> <p>17 "Composite sampling is a flawed methodology to</p> <p>18 adequately" monitor -- sorry. It's a typo, but --</p> <p>19 "adequately monitoring for asbestos and toxic metals and</p> <p>20 should be reserved for products not intended for human</p> <p>21 consumption or cosmetic use." And then you cite to the</p> <p>22 Afewu paper?</p> <p>23 A. That is an editorial error. The Afewu</p> <p>24 reference is there as its own parenthetical sentence.</p> <p>25 Q. So you agree with me --</p>	<p style="text-align: right;">Page 240</p> <p>1 A. No, I did not.</p> <p>2 Q. Do you know if your counsel provided the</p> <p>3 charts that you created to Dr. Cook?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. I don't know if they did or not. I</p> <p>6 presume not. He looked at the same -- I think he looked</p> <p>7 at the same sets of documents. It doesn't surprise me</p> <p>8 that --</p> <p>9 BY MR. FROST:</p> <p>10 Q. That they look exactly the same?</p> <p>11 A -- they're similar. I don't know if</p> <p>12 they're exactly the same. I didn't --</p> <p>13 Q Yeah. You didn't look at it in detail?</p> <p>14 A -- look at Cook's. I didn't look at</p> <p>15 Cook's documents in detail.</p> <p>16 Q. Bear with me a second. I have to go to</p> <p>17 the third box. It's far away.</p> <p>18 (Exhibit 22 was marked for</p> <p>19 identification.)</p> <p>20 VIDEOGRAPHER: I'm going to make a</p> <p>21 general housekeeping announcement. If you've</p> <p>22 got a laptop in front of you and you've got a</p> <p>23 mic on, push it back a little bit and make sure</p> <p>24 your phones stay away from the mic wires.</p> <p>25 Thanks.</p>
<p style="text-align: right;">Page 239</p> <p>1 A. I don't -- it's a typo.</p> <p>2 Q. Okay. So you agree with me that Afewu</p> <p>3 and Lewis don't talk about testing for heavy metals or</p> <p>4 whether or not ores are meant for human consumption?</p> <p>5 A. Correct, yeah. That's a streaming, a</p> <p>6 streaming reference. It's cited where -- it's just</p> <p>7 stand alone. There's a period before it and a period</p> <p>8 after it. Sorry about that.</p> <p>9 Q. That's okay. All right. I'm going to</p> <p>10 turn to the various charts now that are in your report.</p> <p>11 So as a preliminary question, did you review each of the</p> <p>12 documents that are listed in the various documents?</p> <p>13 A. I looked at all these documents, yes.</p> <p>14 Q. Have you ever seen the expert report done</p> <p>15 by Dr. Cook in this case?</p> <p>16 A. Yeah. I have seen it recently, yes.</p> <p>17 Q. It was after you were done drafting your</p> <p>18 initial and supplemental reports? Do you know?</p> <p>19 A. I believe so.</p> <p>20 Q. Okay. I'll note that Dr. Cook seems to</p> <p>21 have the exact same lists that you do. Did you provide</p> <p>22 these to him?</p> <p>23 A. We looked at the same data. I'm sorry.</p> <p>24 Q. Okay. I was going to say, did you</p> <p>25 provide the charts that you created to him?</p>	<p style="text-align: right;">Page 241</p> <p>1 MR. FROST: Can we go off the record for</p> <p>2 a second?</p> <p>3 VIDEOGRAPHER: We're now going off</p> <p>4 record. The time is 5:02.</p> <p>5 (Off the record.)</p> <p>6 VIDEOGRAPHER: We are now back on record,</p> <p>7 and the time is 5:10.</p> <p>8 BY MR. FROST:</p> <p>9 Q. All right, sir. If you look at page 21</p> <p>10 of your report, do you see the sample with the date</p> <p>11 8/22/1985?</p> <p>12 VIDEOGRAPHER: I'm sorry, Counsel. Can</p> <p>13 you put that notebook lid down?</p> <p>14 MR. FROST: Oh.</p> <p>15 VIDEOGRAPHER: Thanks.</p> <p>16 MS. O'DELL: 21.</p> <p>17 A. 21, and what was the line on the table?</p> <p>18 BY MR. FROST:</p> <p>19 Q. 8/22/1985.</p> <p>20 A. Yes.</p> <p>21 Q. I'll move this binder, so it's out of the</p> <p>22 way.</p> <p>23 And that relates to sample WMI 85-28 and</p> <p>24 WMI 85-30?</p> <p>25 A. Yeah, as indicated on the chart.</p>

<p style="text-align: right;">Page 242</p> <p>1 Q. Do you know where Samples 85-28 and 85-30 2 were mined?</p> <p>3 A. I'm looking at the document.</p> <p>4 Q. Yes. If you look for the actual 5 document, if you turn to Tab 1 in the book you have 6 there.</p> <p>7 A. I have Tab 1.</p> <p>8 Q. All right. Great.</p> <p>9 A. All right. Let me just read. Yes. As 10 is common, there's not -- it doesn't say the exact 11 location.</p> <p>12 Q. Would it surprise you to learn that these 13 samples came from a mine in San Andreas, California?</p> <p>14 MS. SCOTT: Objection.</p> <p>15 A. I did not know that.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Turn to Tab 2. It's a document Bates 18 stamped JNJ 65646.</p> <p>19 A. I'm sorry. Tab 2?</p> <p>20 Q. Yeah. Turn to the second page.</p> <p>21 A. Okay. The second page.</p> <p>22 Q. Okay. And if you look at sample WMI 23 85-28, it notes that it's grade TC-700. Do you see 24 that?</p> <p>25 A. 85-28. Oh, okay. Yes.</p>	<p style="text-align: right;">Page 244</p> <p>1 A. Presumably, yeah.</p> <p>2 BY MR. FROST:</p> <p>3 Q. On page 12, if you go down to the next 4 sample listed, it's the 4/29/1986 sample.</p> <p>5 A. I'm sorry. Page 12?</p> <p>6 Q. I'm sorry. I meant page 21. I got it 7 backwards.</p> <p>8 A. Page 21. Okay. And I'm sorry. And what 9 was the line?</p> <p>10 Q. It's the next one down, 4/29/1986.</p> <p>11 A. 4/29/1986. So J&J 182. So is that --</p> <p>12 Q. That's Tab 4.</p> <p>13 A. Tab 4.</p> <p>14 Q. And do you see in the middle of page 15 we're talking here, it's sample number WMI 85-53, WMI 16 85-55 and WMI 85-57?</p> <p>17 A. Yes.</p> <p>18 Q. Okay. And those are the ones that 19 they're talking about in the letter about the chrysotile 20 detection?</p> <p>21 A. Yes.</p> <p>22 Q. Okay. Do you know where these samples 23 were mined?</p> <p>24 A. We can just check. No.</p> <p>25 Q. Turn to Tab 5, sir. And that's the</p>
<p style="text-align: right;">Page 243</p> <p>1 MS. O'DELL: What sample are you on in 2 the chart, Jack? I'm sorry.</p> <p>3 MR. FROST: It's WMI 85-28. It's on page 4 2.</p> <p>5 MS. O'DELL: I've got you. All right.</p> <p>6 BY MR. FROST:</p> <p>7 Q. And then looking down at 85-30, which is 8 the second sample, that is also grade TC-700, correct?</p> <p>9 A. Correct.</p> <p>10 Q. Okay. And those are the two samples we 11 saw from the Tab 1 document that appear in the chart, 12 right?</p> <p>13 A. Yes.</p> <p>14 Q. Okay. You now can turn to Tab 3, which 15 is a document that starts IMERYYS 013723. If you turn to 16 the third page of it. The very bottom of the product 17 certification protocol on page 3. Yeah, I know. It's 18 tiny. I apologize. Do you see where it says, "San 19 Andreas, California, Red Hill Grade," and then it has 20 "TC-700, light" and "dark"?</p> <p>21 A. Yes.</p> <p>22 Q. Okay. This clearly indicates that these 23 two samples did not come from one of the Vermont mines 24 or the Italian or the Chinese mines, correct?</p> <p>25 MS. SCOTT: Object to the form.</p>	<p style="text-align: right;">Page 245</p> <p>1 document with Bates number JNJ 578888. You can turn to 2 the third page.</p> <p>3 A. Where is that on the --</p> <p>4 Q. It's on the --</p> <p>5 A. Chart?</p> <p>6 Q. No. It's the -- I was just identifying 7 for the record the document. It's Tab 5 of the binder.</p> <p>8 A. Tab 5, yes.</p> <p>9 Q. If you turn to the third page --</p> <p>10 MS. SCOTT: 8890.</p> <p>11 BY MR. FROST:</p> <p>12 Q. Yeah, 8890.</p> <p>13 A. Yes.</p> <p>14 Q. Okay. Do you see here on here the WMI 15 85-53 is identified as the grade TC-700?</p> <p>16 A. Yes.</p> <p>17 Q. And that's the one we just saw that comes 18 from the San Andreas, California, mine, correct?</p> <p>19 A. Okay. Yes.</p> <p>20 Q. If you look down at WMI 85-56 and 85-57, 21 which are the other two samples, do you see that one is 22 grade 76 and the other is also grade TC-700?</p> <p>23 A. Yes.</p> <p>24 Q. Okay. So for the TC-700, we know that's 25 San Andreas. If you turn back to Tab --</p>

<p style="text-align: right;">Page 246</p> <p>1 MS. O'DELL: Object to the form.</p> <p>2 BY MR. FROST:</p> <p>3 Q. Turn back to Tab 3.</p> <p>4 MS. O'DELL: Is that a question?</p> <p>5 MR. FROST: Sure.</p> <p>6 BY MR. FROST:</p> <p>7 Q. Do you agree with me that we know from</p> <p>8 looking at the document before that the TC-700 is</p> <p>9 identified as San Andreas, California?</p> <p>10 MS. O'DELL: Object to the form.</p> <p>11 A. I don't remember.</p> <p>12 BY MR. FROST:</p> <p>13 Q. We're going to turn back there. It's Tab</p> <p>14 3, please, in the binder. It's the last page of that</p> <p>15 document.</p> <p>16 A. Right. Oh, okay. Yeah.</p> <p>17 Q. And do you also see the grade 76?</p> <p>18 A. 76 is listed there as well.</p> <p>19 Q. Okay.</p> <p>20 A. Okay. Yes.</p> <p>21 Q. So the samples in this, from this testing</p> <p>22 also did not come from any of the mines utilized by</p> <p>23 Johnson & Johnson for talcum powder, correct?</p> <p>24 MS. O'DELL: Object to the form.</p> <p>25 A. Okay. As far as -- yeah.</p>	<p style="text-align: right;">Page 248</p> <p>1 A. No, not specifically.</p> <p>2 Q. Okay. If you turn to Tab 7, that's the</p> <p>3 document, it's identified as JNJMX68_2659.</p> <p>4 A. JNJMX68_2659. Okay. Where is it in</p> <p>5 the --</p> <p>6 Q. If you look at the third paragraph.</p> <p>7 A. Okay.</p> <p>8 Q. So it's the third and the fifth</p> <p>9 paragraph.</p> <p>10 A. "The samples represented both the</p> <p>11 industrial materials produced at the Gassetts and West</p> <p>12 Windsor."</p> <p>13 Q. Okay. If you look down at the fifth</p> <p>14 paragraph, it says, "In one instance, asbestos was</p> <p>15 identified, this being associated with sample D-GI</p> <p>16 produced at the Gassetts Mill."</p> <p>17 A. Okay.</p> <p>18 Q. And do you agree with me that the</p> <p>19 Gassetts Mill and industrial talc are different than the</p> <p>20 cosmetic talcum powder used in Johnson & Johnson Baby</p> <p>21 Powder -- or Johnson's Baby Powder and Shower to Shower</p> <p>22 products?</p> <p>23 A. The geology is related.</p> <p>24 Q. Okay. But specifically the -- this is</p> <p>25 not talcum powder that ever made it into a bottle of</p>
<p style="text-align: right;">Page 247</p> <p>1 BY MR. FROST:</p> <p>2 Q. Turn to page 19 of your report.</p> <p>3 A. Page 19 of the report?</p> <p>4 Q. Yes. The very bottom, the</p> <p>5 10/10/1974 sample.</p> <p>6 A. Okay.</p> <p>7 Q. And if you look at Tab 7, that's the</p> <p>8 corresponding document. I'm sorry. Tab 6. I</p> <p>9 apologize. Tab 6 is the corresponding document.</p> <p>10 A. J&J-74. Okay.</p> <p>11 Q. Do you see here where it states that the</p> <p>12 sample that came back, the fibrous asbestiform material</p> <p>13 is D-GI? It's in the semi-highlighted section, the gray</p> <p>14 box.</p> <p>15 A. "Only one sample was found to contain</p> <p>16 fibrous asbestiform material."</p> <p>17 Q. And that's D-GI?</p> <p>18 A. D -- okay. If you say -- all right.</p> <p>19 Okay. "7/15 to 7/29. Chrysotile fibers were found to</p> <p>20 be present at an estimated level (good at approximately</p> <p>21 to an order of magnitude) of .006 percent."</p> <p>22 Q. And do you know where this sample was</p> <p>23 mined?</p> <p>24 A. Not specifically, no. I mean it's --</p> <p>25 Q. That -- yeah, I think it's the short --</p>	<p style="text-align: right;">Page 249</p> <p>1 Johnson's Baby Powder or Shower to Shower; is that</p> <p>2 correct?</p> <p>3 MS. SCOTT: Objection.</p> <p>4 A. Presumably, that is correct.</p> <p>5 BY MR. FROST:</p> <p>6 Q. Turn to page 15 of your report.</p> <p>7 A. Page 15?</p> <p>8 Q. Yep.</p> <p>9 A. Of the report? Okay.</p> <p>10 Q. It's the sample 7/7/1971.</p> <p>11 A. 7/7/1971, J&J-15, Colorado School of</p> <p>12 Mines, the Vermont talc.</p> <p>13 Q. And if you turn to Tab 8. This is the</p> <p>14 corresponding document related to processed talc sample</p> <p>15 344-L?</p> <p>16 MS. O'DELL: I'm sorry, Jack. Did you</p> <p>17 say Tab 8?</p> <p>18 MR. FROST: Tab 8 of the binder, yes.</p> <p>19 It's JNJAZ55_6089.</p> <p>20 MS. O'DELL: Great. Thanks.</p> <p>21 A. It says, "only minor amounts (below</p> <p>22 1 percent) of tremolite and actinolite were detected."</p> <p>23 BY MR. FROST:</p> <p>24 Q. Okay. And you agree that this is sample</p> <p>25 344-L that they're talking about?</p>

<p style="text-align: right;">Page 250</p> <p>1 A. Yeah. It says, "Following are results of 2 the x-ray analyses on the 344-L Vermont talc product and 3 the six monthly Vermont talc product samples." Yes. 4 MS. O'DELL: Jack, are you going to 5 mark -- I think what made it to the chart was 6 J&J-15. 7 MR. FROST: I didn't have a copy with the 8 J&J-15 sticker on it. It's the same document, 9 though. This is just from our production. 10 MS. O'DELL: I see. Do you mind giving 11 me just a minute to pull that up -- 12 MR. FROST: Sure. 13 MS. O'DELL: -- so we can correlate it? 14 It will take me two seconds. 15 Thanks very much. 16 BY MR. FROST: 17 Q. If you turn, sir, to page -- or, sorry, 18 to Tab Number 9. Well, before I get there, this report 19 was done by the Colorado School of Mines, correct? 20 A. Colorado School of Mines Research 21 Institute it what it says, yes. 22 Q. Are you aware that the Colorado School of 23 Mines issued a subsequent report regarding these 24 samples? 25 A. I don't know. I believe I've seen other</p>	<p style="text-align: right;">Page 252</p> <p>1 permissible, but, again, you know, it also indicates 2 that they're sloppy with their materials and they -- 3 Q. I'll stop you here. Without speculating, 4 you can't tell me that the talc in 344-L contained 5 asbestos, correct? 6 MS. SCOTT: Object to the form. 7 A. I would say that based on these 8 documents, that, objectively, the analysis might be 9 suspect or based on what I saw previously. 10 BY MR. FROST: 11 Q. Yeah. But you can't tell me one way or 12 the other based on this, considering it's a retraction? 13 A. Well, it was measured once. We don't 14 know -- they didn't -- I don't see any data that backs 15 up -- 16 Q. Well, there's no data in this report. 17 A. It says, I saw where evidently 18 contamination. "Evidently" is a word up to 19 interpretation. Prove it. I don't see, you know, 20 essentially, some sort of chemical analysis or whatever 21 that would prove the exact same thing. 22 Q. So with the guy who did the testing 23 saying my testing is wrong, you're still comfortable in 24 saying 100 percent that there was asbestos in that 25 talcum powder sample?</p>
<p style="text-align: right;">Page 251</p> <p>1 things from the Colorado School of Mines. 2 Q. Okay. If you turn to Tab 9. It's a 3 document identified as JNJAZ55_3828. 4 A. Okay. 5 Q. Do you see it where it says -- it's Point 6 Number 1. "In the report of July 7, 1971." Do you 7 agree with me that's the report you just looked at in 8 Tab 8? 9 A. Okay. 10 Q. Continues down, it says, "Subsequent 11 x-ray work on the six monthly product samples and the 12 344-L product sample shows no definite indications of 13 asbestos-type minerals within our limits of 14 detectability. The trace amounts I saw were evidently 15 contamination from the standard asbestos samples." Did 16 I read that correctly? 17 A. You read it correctly. But it's also, in 18 my mind, it's unclear, you know -- you know, again, 19 like, there's no detail as far as, like, the methods and 20 such. So if they're doing this as powders and then 21 they're reanalyzing, so they're repacking the powder at 22 a sample volume can be several cubic centimeters. So 23 it's not necessarily surprising that we would have a 24 positive result and then, if you repack it, you might 25 get a negative result. And their interpretation is</p>	<p style="text-align: right;">Page 253</p> <p>1 MS. SCOTT: Objection. 2 A. Well, I would say it's probable -- 3 BY MR. FROST: 4 Q. And what's that based on? 5 A. -- or possible. 6 Q. What's your basis? 7 A. The first finding. 8 Q. And the fact that it was negated and 9 specifically retracted by the person who does the 10 testing has absolutely no sway in your mind as to 11 whether or not? You're just now basing your opinion on 12 speculation? 13 MS. SCOTT: Objection. 14 BY MR. FROST: 15 Q. Don't you think the guy who did the test 16 is in a better position than you are today, 40, 50 years 17 later, to say what was in that particular sample that he 18 tested? 19 MS. O'DELL: Objection. 20 A. I've stated my opinion. 21 BY MR. FROST: 22 Q. Okay. Interesting one. Let's turn to 23 1972. It's page 16. 24 A. There's many from '72 here. Which one? 25 Q. It's the very -- it's 8/3/1972.</p>

<p style="text-align: right;">Page 254</p> <p>1 A. "8/3/1972, J&J-28, NYU, Shower to Shower 2 ... 5 percent chrysotile." 3 Q. Turn to Tab 8. I'm sorry. Tab 10. 4 A. Tab 10. 5 Q. Do you agree this is a corresponding 6 document to that entry? 7 A. J&J-28. Yes. 8 Q. Okay. Real quick, before I get there, 9 turning back to Tab 9, you were never provided with this 10 document, right? 11 MS. SCOTT: Objection. 12 A. Tab 9. I think I was. 13 BY MR. FROST: 14 Q. And then why didn't you consider this 15 document in creating your chart? 16 MS. SCOTT: Objection. 17 A. I potentially missed it in the 18 compilation. 19 BY MR. FROST: 20 Q. And you also didn't include it under 21 materials considered? 22 A. I missed it. 23 Q. Okay. So back to Tab 10. So we agree 24 this is the source of the entry on page 16 of your 25 report, correct? The Shower to Shower sample 84.</p>	<p style="text-align: right;">Page 256</p> <p>1 MS. O'DELL: Give us just a minute. 2 A. Here's one by Doctor -- I'm sorry. I'm 3 getting Dr. Lewin-- okay. D. You said D-1? 4 MS. O'DELL: Is it DX? 5 MR. FROST: I have it as D. It's 6 possible it's DX. 7 A. So let's see what the date is. We have a 8 date. We're looking for January 7th, '76. January 7th, 9 '76. I think there's only -- I have one. I have only 10 one. 11 BY MR. FROST: 12 Q. Sir, we're trying to pull up the 13 documents, but this relates -- and I'll get back -- but 14 this relates to your testing of 8/3/72 by Dr. Lewin. 15 The Shower to Shower sample 84, you note on the 8/3/72. 16 If you look back at Tab 10, that's the corresponding 17 document for that. It's on the one, two, three, four, 18 five, sixth page. 19 MS. SCOTT: Is subsection B on the 20 tabulation of Dr. Lewin's original findings 21 smudged? 22 MR. FROST: Yeah, it's smudged, too. 23 MS. SCOTT: Okay. 24 MR. FROST: Yeah. Mine looks the same. 25 MS. SCOTT: Got it. And that's the</p>
<p style="text-align: right;">Page 255</p> <p>1 A. Yeah. J&J-28? 2 Q. Yes. 3 A. Yes. 4 Q. Okay. And this was testing that was done 5 by Dr. Lewin? 6 A. Yes. 7 Q. Are you aware that Dr. Lewin retested 8 this sample and was unable to replicate his results? 9 A. No. 10 Q. Okay. Turn to Tab 11. If you look at 11 page 4, it's the testing of Number 29. I think it's 12 four -- three down. 13 A. It is one, two, three, four. And I'm 14 sorry. This is -- 15 Q. Yes. That's the chart. 16 A. Where? I don't see a number on this. 17 Q. Yeah. It appears to have gotten cut off, 18 so I don't know what the number of this document is. We 19 can sort that out at the back end. 20 A. Where is it at on the chart? 21 Q. It's D-7113. As I said, it got cut off. 22 MS. O'DELL: Yeah. Was it marked in a 23 deposition? 24 MR. FROST: I believe it is. It's marked 25 somewhere, but I have it in my notes as D-7113.</p>	<p style="text-align: right;">Page 257</p> <p>1 original? 2 MR. FROST: Yes. My understanding is 3 that's the original. 4 BY MR. FROST: 5 Q. Okay. So you see we're talking about 6 Sample 84 on Tab 10? 7 A. Right. So I'm at Tab 10. Tab 10. 8 Q. One, two, three, four -- it's the fifth 9 page. 10 A. One, two, three, four, five. 11 Q. Do you see a Product 84? 12 A. Product 84? Yes. 13 Q. And if you follow across, there's -- 14 A. 5 percent chrysotile. 15 Q. -- 5 percent chrysotile. Okay. So if 16 you turn to the document at Tab 11. 17 MS. O'DELL: I'm not able to find that 18 DX. 19 MR. FROST: Okay. Well, I'll provide it 20 to you after the deposition. We'll figure it 21 out. 22 BY MR. FROST: 23 Q. So if you look at this, this document, 24 you go to the fourth page. Sorry. One, two, three, 25 fourth page.</p>

<p style="text-align: right;">Page 258</p> <p>1 A Okay. One, two, three, four.</p> <p>2 Q. Do you see here under Sample 84 with the</p> <p>3 retest that there's a no detect and there's no finding</p> <p>4 of chrysotile?</p> <p>5 MS. SCOTT: Objection.</p> <p>6 A. In the -- oh, there's a question mark for</p> <p>7 chrysotile, right?</p> <p>8 BY MR. FROST:</p> <p>9 Q. Yeah. It certainly doesn't find that</p> <p>10 there's chrysotile in the retest, correct?</p> <p>11 MS. SCOTT: Objection.</p> <p>12 A. It doesn't say "no detect," also.</p> <p>13 BY MR. FROST:</p> <p>14 Q. Again, without speculating, can you tell</p> <p>15 me whether or not that that means there's chrysotile in</p> <p>16 that product?</p> <p>17 A. No. But it means there's some question.</p> <p>18 Yeah, I don't know why they would use question marks.</p> <p>19 If it was no detect, I would expect it to be an ND.</p> <p>20 Q. But, again, you can't tell me one way or</p> <p>21 the other without speculating that there's chrysotile in</p> <p>22 that product, correct?</p> <p>23 MS. O'DELL: Object to the form.</p> <p>24 A. So with all these, you know, re-analyses,</p> <p>25 you know, essentially, one aspect of variability is that</p>	<p style="text-align: right;">Page 260</p> <p>1 Powder, 3 percent chrysotile.</p> <p>2 Q. You're looking at page 4 of 7?</p> <p>3 A. 4 of 7.</p> <p>4 Q. Samples 183 and 184?</p> <p>5 A. Yes.</p> <p>6 Q. If you look back at Tab 11. If you look</p> <p>7 at Samples 133 and 134 here. Again, on the retest, this</p> <p>8 time there's no question mark. It says nondetect for</p> <p>9 chrysotile, tremolite. Do you agree?</p> <p>10 A. 133 and 134, ND. Yes, ND is listed.</p> <p>11 Q. And if you look back at your chart on</p> <p>12 16 -- strike that.</p> <p>13 So, again, looking at this, you can't</p> <p>14 tell me whether or not there's actually asbestos that</p> <p>15 made it into the sample that's listed as 9/26/72 in your</p> <p>16 chart, correct, without speculating?</p> <p>17 A. Correct. It was detected once in a</p> <p>18 sample, and it was not detected again in what is</p> <p>19 supposedly the same sample. So I'm unclear. Is it the</p> <p>20 exact -- is it the same exact sample or same lot?</p> <p>21 Q. It's the same sample, sir. It was</p> <p>22 retesting of the same sample.</p> <p>23 A. Resting.</p> <p>24 MS. O'DELL: Object to the form.</p> <p>25 A. Is the exact --</p>
<p style="text-align: right;">Page 259</p> <p>1 perhaps the samples were either ground more or not</p> <p>2 prepared, you know, in the same way.</p> <p>3 BY MR. FROST:</p> <p>4 Q. Let's stop you here. You're speculating</p> <p>5 about all of this, correct? Based on these documents,</p> <p>6 can you tell me one way or the other that there was any</p> <p>7 problems with the retest or that they've actually found</p> <p>8 chrysotile in any of these samples? I don't want you to</p> <p>9 speculate.</p> <p>10 MS. SCOTT: Object to the form.</p> <p>11 A. The -- this has a question mark listed</p> <p>12 for chrysotile.</p> <p>13 BY MR. FROST:</p> <p>14 Q. And based on that, you can't tell me one</p> <p>15 way or the other whether there was chrysotile in the</p> <p>16 final sample that was tested, according to this</p> <p>17 document, correct?</p> <p>18 A. Correct. According to that document.</p> <p>19 Q. Okay. Go to your chart. Still on page</p> <p>20 16, I believe. It's 9/26/72.</p> <p>21 A. 9/26/72.</p> <p>22 Q. If you turn to Tab 12. Do you agree that</p> <p>23 that's the corresponding document, J&J-31?</p> <p>24 A. JNJ-31. I believe so, yes. Johnson's</p> <p>25 Baby Powder, 2 percent chrysotile; Johnson's Baby</p>	<p style="text-align: right;">Page 261</p> <p>1 MS. O'DELL: Excuse me. Object to the</p> <p>2 form.</p> <p>3 BY MR. FROST:</p> <p>4 Q. You can read the document yourself, sir.</p> <p>5 All right. So I think we've gone</p> <p>6 through, like, six of these, correct? And we've come up</p> <p>7 with six of them either are samples that have absolutely</p> <p>8 nothing to do with Johnson's Baby Powder or Shower to</p> <p>9 Shower or any other cosmetic talcum problem. Do you</p> <p>10 agree? Talcum powder product.</p> <p>11 MS. O'DELL: Objection.</p> <p>12 BY MR. FROST:</p> <p>13 Q. Do you agree?</p> <p>14 A. We've gone through six examples as</p> <p>15 you've -- yeah.</p> <p>16 Q. And others we've come up with, we</p> <p>17 basically determined without speculating you can't say</p> <p>18 one way or the other that there is asbestos in that</p> <p>19 product that made it onto the market, correct?</p> <p>20 MS. SCOTT: Object to the form.</p> <p>21 A. Based on those documents, yes.</p> <p>22 BY MR. FROST:</p> <p>23 Q. So I think it would take us days to go</p> <p>24 through all of these, but can you definitively sit here</p> <p>25 now and tell me that every single hit or every single</p>

<p style="text-align: right;">Page 262</p> <p>1 reference you have on this list showing asbestos and</p> <p>2 talcum powder is actually talcum powder that was, one,</p> <p>3 either use or ended up in an bottle of Johnson's Baby</p> <p>4 Powder or Shower to Shower or other talcum powder</p> <p>5 products or, two, that you can say without speculating</p> <p>6 contains asbestos?</p> <p>7 MS. O'DELL: Objection.</p> <p>8 A. To the best of my knowledge, I stand by</p> <p>9 the report.</p> <p>10 BY MR. FROST:</p> <p>11 Q. But sitting here today, you can't tell me</p> <p>12 one way or the other that absolutely every -- well, we</p> <p>13 know not every single entry is correct?</p> <p>14 MS. O'DELL: Objection.</p> <p>15 A. Yeah. So there -- there are some</p> <p>16 misidentifications or later corrections, later</p> <p>17 corrections that I was unaware of, but it's also</p> <p>18 concerning that you can -- it's not exactly -- you know,</p> <p>19 so what is a sample? It's not exactly clear if the</p> <p>20 sample is like a kilogram sample, so you could have</p> <p>21 portions in that sample that have asbestos that you</p> <p>22 cannot detect, and then you can have regions of the</p> <p>23 sample that have a lot. So that, that's my opinion.</p> <p>24 Q. So what you're telling me is you can't</p> <p>25 actually speculate as to any of the testing results in</p>	<p style="text-align: right;">Page 264</p> <p>1 they provided to you?</p> <p>2 MS. SCOTT: Objection.</p> <p>3 A. No. But I -- well, I remember there's a</p> <p>4 deposition by Blount who indicated, I think, on page 10</p> <p>5 that work from 1991 was Johnson & Johnson talcum powder,</p> <p>6 if I remember correctly. I've seen that somewhere.</p> <p>7 BY MR. FROST:</p> <p>8 Q. Okay. So Blount, Longo. And, again,</p> <p>9 Blount was provided to you by plaintiffs' counsel,</p> <p>10 correct?</p> <p>11 A. Yes.</p> <p>12 Q. Now, you've done no additional testing</p> <p>13 yourself of talcum powder? I think you said that</p> <p>14 before.</p> <p>15 A. Correct. Yeah. That was not requested</p> <p>16 of me.</p> <p>17 Q. And have you done any testing or cusing</p> <p>18 of the testing done by Dr. Longo?</p> <p>19 MS. SCOTT: Objection. Asked and</p> <p>20 answered.</p> <p>21 A. No. I was not asked to retest on any of</p> <p>22 his samples or anything like that.</p> <p>23 BY MR. FROST:</p> <p>24 Q. So you're merely relying on the results</p> <p>25 of his testing for purposes of your opinions here,</p>
<p style="text-align: right;">Page 263</p> <p>1 here because of the various sample sizes retesting, and</p> <p>2 again, not everything we found is a retest, right? Some</p> <p>3 aren't even products of cosmetic talc, correct?</p> <p>4 MS. O'DELL: Object to the form.</p> <p>5 MS. SCOTT: Objection.</p> <p>6 A. I don't remember.</p> <p>7 BY MR. FROST:</p> <p>8 Q. You don't remember that we found talcum</p> <p>9 powder that came from a mine in San Andreas, California?</p> <p>10 A. I'm sorry. Yeah, that's correct.</p> <p>11 Q. Okay. So it's not just retesting that</p> <p>12 came back. I've also identified some product that has</p> <p>13 nothing to do with cosmetic talcum powder, correct?</p> <p>14 MS. SCOTT: Objection.</p> <p>15 A. Correct.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Okay. Now, you also reference in your</p> <p>18 report Dr. Longo's reports; is that correct?</p> <p>19 A. Yes.</p> <p>20 Q. And I take it you were provided those</p> <p>21 reports by plaintiffs' counsel?</p> <p>22 A. Yes.</p> <p>23 Q. Did you ever ask plaintiffs' counsel if</p> <p>24 anybody else has done testing of Johnson & Johnson</p> <p>25 talcum powder other than Dr. Longo and the records that</p>	<p style="text-align: right;">Page 265</p> <p>1 correct?</p> <p>2 A. Yes.</p> <p>3 Q. You have no opinions about his sample</p> <p>4 preparation, his underlying testing methods, anything of</p> <p>5 that nature?</p> <p>6 A. I'm fine with what he's done.</p> <p>7 Q. Okay. But you're not rendering any</p> <p>8 opinions that it's correct or incorrect or the</p> <p>9 methodology about it? You're not going to sit here</p> <p>10 today and walk me through the methodology that Longo</p> <p>11 used to give me opinions that that's the proper way or</p> <p>12 not the proper way?</p> <p>13 MS. SCOTT: Objection.</p> <p>14 A. I think what he did was fine for the</p> <p>15 purpose of the report.</p> <p>16 BY MR. FROST:</p> <p>17 Q. You have no problems with any of the</p> <p>18 methodology he employed in his testing?</p> <p>19 MS. O'DELL: Objection. Asked and</p> <p>20 answered.</p> <p>21 A. No. I'm fine with what he's done in the</p> <p>22 report.</p> <p>23 BY MR. FROST:</p> <p>24 Q. This is despite the fact that you've done</p> <p>25 nothing to verify the results of his report?</p>

<p style="text-align: right;">Page 266</p> <p>1 MS. SCOTT: Objection.</p> <p>2 A. You know, I looked at a lot of TEM data.</p> <p>3 You know, just looking at the quality of the data,</p> <p>4 electron diffraction is, requires a certain level of</p> <p>5 skill, and he produced several, you know, really good</p> <p>6 nets, so he was obviously able to get good orientations</p> <p>7 of crystals. So, you know, he didn't have anything that</p> <p>8 was extremely off axis or anything like that. So at</p> <p>9 that level, I mean, I am fine with his data.</p> <p>10 BY MR. FROST:</p> <p>11 Q. You didn't go through and actually run</p> <p>12 any calculations to determine whether or not his</p> <p>13 accessees were correct or whether or not any of his</p> <p>14 underlying calculations or determinations are correct?</p> <p>15 MS. SCOTT: Objection. Asked and</p> <p>16 answered.</p> <p>17 A. I did not index things, but the</p> <p>18 diffraction patterns looked suitable and consistent as</p> <p>19 to the EDS, suitable and consistent with the materials</p> <p>20 that he identified.</p> <p>21 BY MR. FROST:</p> <p>22 Q. And is suitable and consistent the</p> <p>23 scientific requirement for testing?</p> <p>24 MS. SCOTT: Objection.</p> <p>25 A. So with TEM work, essentially, one should</p>	<p style="text-align: right;">Page 268</p> <p>1 found asbestos in every sample he tested?</p> <p>2 A. I would not be comfortable saying that.</p> <p>3 I don't know.</p> <p>4 Q. Okay.</p> <p>5 A. I know he found asbestos in many samples.</p> <p>6 Q. Okay. Turning to -- where I did put your</p> <p>7 report?</p> <p>8 THE WITNESS: Can we take a little break?</p> <p>9 MR. FROST: Sure.</p> <p>10 VIDEOGRAPHER: We're now going off</p> <p>11 record. The time is 5:47.</p> <p>12 (A recess was taken from 5:47 to 6:00.)</p> <p>13 VIDEOGRAPHER: We are back on record, and</p> <p>14 the time is 6:00.</p> <p>15 BY MR. FROST:</p> <p>16 Q. We're going to change gears a little bit</p> <p>17 and talk about fibrous talc. Of course, I'm not finding</p> <p>18 it. That's all right. It doesn't matter.</p> <p>19 So, in general, you're relying on the</p> <p>20 IARC statement from 2012, correct, that fibrous talc is</p> <p>21 carcinogenic?</p> <p>22 A. I'm just trying to find it.</p> <p>23 BY MR. FROST:</p> <p>24 Q. If you find it, tell me the page. Okay.</p> <p>25 Page 23 is where it starts.</p>
<p style="text-align: right;">Page 267</p> <p>1 have an image, an EDS pattern and a diffraction pattern.</p> <p>2 So I find what he has done is in agreement with what I</p> <p>3 would do and what others have done.</p> <p>4 BY MR. FROST:</p> <p>5 Q. This is despite the fact that you didn't</p> <p>6 do any retesting of the work calculations. You didn't</p> <p>7 do any cusing of it. You're just taking it a face value</p> <p>8 based on your review?</p> <p>9 MS. SCOTT: Objection.</p> <p>10 A. I was not tasked with retesting samples.</p> <p>11 BY MR. FROST:</p> <p>12 Q. You agree with me that there are samples</p> <p>13 where Dr. Longo detected no asbestos, correct?</p> <p>14 A. I'm not sure. There may have been some,</p> <p>15 but I don't remember the exact details.</p> <p>16 Q. So you're relying on Dr. Longo's report</p> <p>17 and testing as a basis for your opinions here, but you</p> <p>18 can't even tell me whether or not what percentage or if</p> <p>19 he finds no asbestos in some of the bottles he tested?</p> <p>20 MS. SCOTT: Objection.</p> <p>21 A. There were, you know, hundreds and</p> <p>22 hundreds of images diffraction patterns in EDS, so I</p> <p>23 don't remember specifics.</p> <p>24 BY MR. FROST:</p> <p>25 Q. So you can't tell me whether or not he</p>	<p style="text-align: right;">Page 269</p> <p>1 A. Twenty-three.</p> <p>2 Q. In general, I think a couple different</p> <p>3 places in your report, you note that, according to IARC,</p> <p>4 it's actually -- I see it on page 3. Yeah, that rely on</p> <p>5 IARC 2012 to state that fibrous talc can be a human</p> <p>6 carcinogen?</p> <p>7 A. I'm sorry. You said page 3?</p> <p>8 Q. Yes.</p> <p>9 A. Page 3.</p> <p>10 MS. SCOTT: I'll just object.</p> <p>11 A. "Talc can occur in a fibrous habit"?</p> <p>12 Q. Yep.</p> <p>13 A. "These fibers can be inhaled into the</p> <p>14 lower lungs based on their length and diameter,</p> <p>15 producing effects linked to significant health risks in</p> <p>16 humans. IARC 2012."</p> <p>17 BY MR. FROST:</p> <p>18 Q. Okay. Would you agree with me that</p> <p>19 you're not an expert in reading the literature of what</p> <p>20 causes cancer?</p> <p>21 MS. SCOTT: Objection.</p> <p>22 A. I am not an oncologist. I am not a</p> <p>23 medical expert.</p> <p>24 BY MR. FROST:</p> <p>25 Q. Do you agree with me that an IARC</p>

<p style="text-align: right;">Page 270</p> <p>1 monograph does not represent independent lab work but, 2 instead, it's a summary of work that's already been done 3 by others? 4 MS. SCOTT: Objection. 5 A. And that's normal. There are many 6 monographs. I mean, we have, you know, the CRC 7 chemistry book. 8 BY MR. FROST: 9 Q. That's what I'm saying. 10 A. It is a cumulative document, as I 11 understand it, based on peer-review literature, and it's 12 also an international document, so it's global 13 peer-review literature, as I understand it. 14 Q. Do you agree with me that if there are -- 15 IARC does not draw conclusions on its own, so if there's 16 not peer-reviewed literature that says one way or the 17 other, IARC isn't going to jump out and say this is or 18 this isn't, correct? IARC relies on the work of others 19 in order to reach its conclusions? 20 MS. O'DELL: Object to form. 21 A. I think it's speculation because I'm not 22 an expert in health and medical things. 23 BY MR. FROST: 24 Q. Okay. Are you aware whether or not there 25 are any peer-reviewed studies that actually link</p>	<p style="text-align: right;">Page 272</p> <p>1 BY MR. FROST: 2 Q. If you want me to explain it -- 3 A. I don't -- I don't remember. 4 Q. And that, specifically, the theory is 5 that -- you know, the explanation is that if you look at 6 talc edge on, it can appear in a 2-D image as fibrous. 7 Would you agree with that? 8 MS. SCOTT: Objection. 9 A. Can I make a statement? 10 BY MR. FROST: 11 Q. Sure. 12 A. So the miopyroboles are this mineral 13 group that actually were discovered in the ultramafic, 14 these talc-rich zones in Vermont. So Dave Devlin, I 15 worked with Thompson at Harvard, and basically, what 16 they showed is that you can have these structural 17 intermediates where, essentially, you can have a region 18 of a crystal. 19 Q. Okay. I am going to stop you because we 20 are talking about something completely different. My 21 question was -- 22 A. I was explaining how one might get 23 fibrous talc. 24 Q. No, no. I'm talking about -- that's why 25 I stopped you, because that's not what we're talking</p>
<p style="text-align: right;">Page 271</p> <p>1 exposure to talc to ovarian cancer? 2 MS. SCOTT: Objection. 3 MS. O'DELL: Object to form. 4 A. I'm sorry. Any studies or any 5 information? 6 BY MR. FROST: 7 Q. I said any peer-reviewed studies linking 8 exposure to talc to ovarian cancer. 9 A. I'm not a medical expert. 10 Q. Again, can you tell me whether or not 11 IARC specifically links exposure to talc to ovarian 12 cancer? 13 MS. SCOTT: Objection. Asked and 14 answered. 15 MS. O'DELL: Objection. 16 A. I'm not a medical expert. 17 BY MR. FROST: 18 Q. Have you ever done any work identifying 19 talc as either platy or fibrous? 20 A. No. I have no peer-reviewed articles. 21 Q. Are you aware if you ever heard of the 22 common misreporting of platy talc as fibrous? 23 MS. SCOTT: Objection. 24 MS. O'DELL: Objection. 25</p>	<p style="text-align: right;">Page 273</p> <p>1 about. 2 So do you agree that if you're looking at 3 a plate of talc on edge, it can appear as a fiber in a 4 2-D SEM or TEM image? And have you read any literature 5 about the problems with misidentifying talc? 6 MS. O'DELL: Objection. 7 MS. SCOTT: Objection. 8 A. It can look -- so a fibrous -- a fiber 9 can look like a two-dimensional plate or a 10 two-dimensional plate can look like a fiber. 11 BY MR. FROST: 12 Q. So the problem is when you're looking -- 13 because, usually, a platy talc, you know, if it's 14 sitting oriented this way, you can see the large 15 platiness of it, but if it's oriented that you're 16 looking at the flat plane, have you ever read anything 17 that talks about the fact that you can misidentify platy 18 talc as fiber based on the orientation of the image? 19 MS. SCOTT: Objection. 20 A. I don't remember. 21 MR. FROST: Can we get IARC 2010? I 22 forget what that was marked as. It's the big 23 orange one, I believe. Yeah, there it is. 24 MS. O'DELL: Five. 25 MR. FROST: It looks like that. It's</p>

<p style="text-align: right;">Page 274</p> <p>1 five.</p> <p>2 BY MR. FROST:</p> <p>3 Q. I'll skip this. You said you haven't</p> <p>4 read anything. You don't know about that, so it's not</p> <p>5 something that comes up in your work?</p> <p>6 A. I don't remember.</p> <p>7 Q. That's fine. I'll move on for sake of</p> <p>8 time. All right.</p> <p>9 Now, you've also noted in your report</p> <p>10 various opinions about findings of nickel, chromium and</p> <p>11 cobalt, correct?</p> <p>12 A. Yes.</p> <p>13 Q. And you're not qualified to opine as to</p> <p>14 whether or not a particular level of nickel is</p> <p>15 sufficient to cause human disease, correct?</p> <p>16 MS. SCOTT: Objection.</p> <p>17 A. I am not a toxicologist.</p> <p>18 BY MR. FROST:</p> <p>19 Q. You're also not qualified to opine what,</p> <p>20 if any, disease may be associated with nickel</p> <p>21 contaminated or with nickel exposure, correct?</p> <p>22 MS. SCOTT: Objection.</p> <p>23 A. I'm not a toxicologist or oncologist.</p> <p>24 BY MR. FROST:</p> <p>25 Q. I'm looking at your report, starting on</p>	<p style="text-align: right;">Page 276</p> <p>1 finished talcum powder, correct?</p> <p>2 MS. SCOTT: Objection.</p> <p>3 MS. O'DELL: Objection.</p> <p>4 A. I'm sorry. Repeat the question.</p> <p>5 BY MR. FROST:</p> <p>6 Q. Sure. You can't tell me without</p> <p>7 speculating that levels of -- we're looking at nickel,</p> <p>8 for example, here, found in ore samples are the same</p> <p>9 levels that would be located in finished talcum powder,</p> <p>10 correct?</p> <p>11 MS. SCOTT: Objection.</p> <p>12 A. Correct. The levels of metals may be the</p> <p>13 same, may be less or may be more depending upon the</p> <p>14 process.</p> <p>15 BY MR. FROST:</p> <p>16 Q. And things like beneficiation, blending,</p> <p>17 things of this nature would ultimately affect what ends</p> <p>18 up in the final product, right?</p> <p>19 A. If it's executed correctly, but I think</p> <p>20 it's also reasonable to say that some -- it is</p> <p>21 scientifically likely -- it's my opinion that some of</p> <p>22 this would, from the ore samples, would make it into</p> <p>23 product if it is used for that purpose.</p> <p>24 Q. But you can't tell me, of these ore</p> <p>25 samples, what sample may or may not have made --</p>
<p style="text-align: right;">Page 275</p> <p>1 page 34.</p> <p>2 A. I'm right there.</p> <p>3 Q. Some of these tests, you'll agree with</p> <p>4 me, you know, not that they're from ore. Several of</p> <p>5 them actually note that they're from ore grade 66.</p> <p>6 Windsor 66, you agree, is an ore, correct?</p> <p>7 MS. O'DELL: Object to the form.</p> <p>8 A. I'm sorry?</p> <p>9 BY MR. FROST:</p> <p>10 Q. You'd agree with me, looking at these,</p> <p>11 that the marks that say "ore in concentrate, grade 66,</p> <p>12 Windsor 66," et cetera, these are all ore samples,</p> <p>13 correct?</p> <p>14 MS. SCOTT: Objection.</p> <p>15 A. I think so. I'd like to look at the</p> <p>16 document to be sure.</p> <p>17 BY MR. FROST:</p> <p>18 Q. I mean, you can go on them, such as the</p> <p>19 example of Imerys 045182. It says three ore samples?</p> <p>20 A. Yeah. So that's what it's listed as,</p> <p>21 yes.</p> <p>22 Q. So you'd agree with me without</p> <p>23 speculating, you can't say one way or the other that</p> <p>24 levels, as detected in the ore samples, are actually the</p> <p>25 levels that may have ever made it into a bottle of</p>	<p style="text-align: right;">Page 277</p> <p>1 A. I can't tell you where, what bottle that</p> <p>2 might have ended up in, yes.</p> <p>3 Q. Or if it even could have ended up in the</p> <p>4 bottle, correct?</p> <p>5 MS. SCOTT: Objection.</p> <p>6 BY MR. FROST:</p> <p>7 Q. At that --</p> <p>8 A. Specifically, no.</p> <p>9 Q. Okay.</p> <p>10 A. If you process it, you may modify it one</p> <p>11 way or the other.</p> <p>12 Q. The same thing would also be true with</p> <p>13 respect to the chromium, cobalt, and I think this is the</p> <p>14 only other ones, right, chromium, cobalt that are listed</p> <p>15 in the charts? Yes.</p> <p>16 MS. SCOTT: Objection.</p> <p>17 BY MR. FROST:</p> <p>18 Q. The same would be true with chromium and</p> <p>19 cobalt, right?</p> <p>20 A. Chromium, cobalt, nickel. Chromium</p> <p>21 cobalt, nickel -- I'm just checking and double checking.</p> <p>22 Chromium, cobalt, and then it's not in chart form, but I</p> <p>23 do talk about arsenic on page 33.</p> <p>24 Q. And it would be the same for the</p> <p>25 chromium, cobalt, nickel and arsenic based on ore sample</p>

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<p>1 testing? You couldn't say one way or the other what</p> <p>2 level ultimately made it into, if at all, talcum powder,</p> <p>3 finished talcum powder, correct?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. Yes.</p> <p>6 BY MR. FROST:</p> <p>7 Q. With respect to chromium, which is page</p> <p>8 36 of your report, sir?</p> <p>9 A. Uh-huh.</p> <p>10 Q. You know that chromium can occur in two</p> <p>11 different forms, Chromium III and Chromium VI?</p> <p>12 A. It's a slight typo. What I mean to say</p> <p>13 there is chromium can occur in two common forms and</p> <p>14 minerals, Chromium III and Chromium IV. So chromium can</p> <p>15 actually have several different valent states to it --</p> <p>16 Q. And it's Chromium VI --</p> <p>17 A. -- including the zero valent metal, which</p> <p>18 we don't really see in nature.</p> <p>19 Q. And it's chromium 6, correct, that is the</p> <p>20 known carcinogen?</p> <p>21 A. Yeah. That is one of high concern, as I</p> <p>22 understand it.</p> <p>23 Q. Are you generally aware that Chromium III</p> <p>24 is actually an essential element in the human body?</p> <p>25 A. I'm a diabetic. Yes.</p>	<p>1 Q. It you turn to, I believe, Exhibit 2,</p> <p>2 your supplemental report.</p> <p>3 A. Okay.</p> <p>4 Q. Okay. The second page.</p> <p>5 A. Okay.</p> <p>6 Q. Under sampling and techniques, do you see</p> <p>7 it's one, two, three, four down?</p> <p>8 A. Under "Sampling and Testing"?</p> <p>9 Q. Under "Sampling and Testing Results,"</p> <p>10 yes. You know that it failed to provide data</p> <p>11 supporting -- no. I'm in the wrong place.</p> <p>12 A. I'm sorry. Where were you?</p> <p>13 Q. Sorry. I was in the wrong place. Bear</p> <p>14 with me a second here. Okay. It's the one, two, third</p> <p>15 paragraph down. It starts with "Another issue."</p> <p>16 A. Yeah.</p> <p>17 Q. So "Another issue was the vague</p> <p>18 description of the preparation technique. The method</p> <p>19 fails to identify whether the material was ground,</p> <p>20 crushed or made into a powder by another method." Do</p> <p>21 you see that there?</p> <p>22 A. Yes.</p> <p>23 Q. If you look up to the testing, it says,</p> <p>24 "XRD methodology states." Do you see where I am there?</p> <p>25 A. Yes.</p>
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<p>1 Q. Okay. And are you also aware that</p> <p>2 chromium 3 is commonly found in rocks and minerals?</p> <p>3 A. Yes.</p> <p>4 Q. And, again, in looking at the chart, you</p> <p>5 don't list here whether or not it is Chromium III,</p> <p>6 Chromium VI or some other variant of the mineral -- or</p> <p>7 the metal, correct?</p> <p>8 A. Correct. But I think it's reasonable</p> <p>9 that -- yes. There's no specific determination of</p> <p>10 valent state, which would have been a nice step if you</p> <p>11 could definitively show that there is no chromium or</p> <p>12 active valent chromium that would have been a good</p> <p>13 thing. But, yes, there's no specific EELS, electron</p> <p>14 energy loss spectroscopy, or what comes through</p> <p>15 techniques to determine that.</p> <p>16 Q. And with respect to the arsenic, the</p> <p>17 cobalt and the chromium, just like the nickel, you can't</p> <p>18 tell me what level of exposure is required to cause</p> <p>19 disease of those heavy metals, correct?</p> <p>20 A. I am not a medical or oncologist, sir,</p> <p>21 yes.</p> <p>22 Q. And it's the same thing. You couldn't</p> <p>23 tell me what diseases they're known to cause if you have</p> <p>24 exposure, correct?</p> <p>25 A. Correct.</p>	<p>1 Q. It's the part that's indented.</p> <p>2 Underneath, it says, "Monthly talc composite, February</p> <p>3 1990."</p> <p>4 A. Yeah.</p> <p>5 Q. Do you agree with me that the monthly</p> <p>6 talc composite is a composite of the ground finished</p> <p>7 talc that's being tested?</p> <p>8 MS. SCOTT: Objection.</p> <p>9 A. I'm unsure. I'm unsure. The -- you --</p> <p>10 one would essentially prepare the -- I'm sorry. Go</p> <p>11 ahead.</p> <p>12 BY MR. FROST:</p> <p>13 Q. Yes.</p> <p>14 A. I'm unsure.</p> <p>15 Q. You can't tell me whether or not this was</p> <p>16 the composite sample of the already ground and prepared</p> <p>17 talc?</p> <p>18 A. I don't -- I don't remember specifically.</p> <p>19 Q. And if the talc was already ground as a</p> <p>20 finished product, there wouldn't be further grinding of</p> <p>21 it. Do you agree with that?</p> <p>22 MS. SCOTT: Objection.</p> <p>23 A. So as I understand, the final talc</p> <p>24 particle size is approximately 15, 25 microns or so, so</p> <p>25 that's essentially fine salt size. So, typically, in</p>

<p style="text-align: right;">Page 282</p> <p>1 power diffraction, you would want to reduce that</p> <p>2 particle size further.</p> <p>3 BY MR. FROST:</p> <p>4 Q. Did you see anywhere in reviewing this</p> <p>5 testing that they state that they reduce the particle</p> <p>6 size further?</p> <p>7 MS. O'DELL: If you need to review the</p> <p>8 document, Doctor, we can pull it.</p> <p>9 A. Yeah. Why don't we pull it up?</p> <p>10 BY MR. FROST:</p> <p>11 Q. Sure. I don't have it. That's fine. We</p> <p>12 can move on. I don't want to waste my time.</p> <p>13 MS. O'DELL: To ask him questions,</p> <p>14 specific questions about the document not having</p> <p>15 this.</p> <p>16 MR. FROST: I'm just asking -- I'm just</p> <p>17 asking if he knows and what he remembers in</p> <p>18 drafting his report.</p> <p>19 All right, sir. I think that's all the</p> <p>20 questions I have for now. I reserve the right</p> <p>21 to look at my notes and come back, but I'm going</p> <p>22 to yield my time to some of the other</p> <p>23 defendants. We can go off the record.</p> <p>24 VIDEOGRAPHER: We're now going off</p> <p>25 record. The time is 6:19.</p>	<p style="text-align: right;">Page 284</p> <p>1 A. Yes.</p> <p>2 Q. And you've published a hundred and</p> <p>3 something; is that right?</p> <p>4 A. Over 40 peer-review papers. I have over</p> <p>5 a hundred presentations at meetings and a couple</p> <p>6 patents, yes.</p> <p>7 Q. In your peer-review papers, when you're</p> <p>8 citing authorities in your peer-review papers, you tend</p> <p>9 to or customarily cite peer-reviewed papers, don't you?</p> <p>10 A. Generally, yes.</p> <p>11 Q. Because you know that they have the</p> <p>12 likelihood to be more accurate and have been, obviously,</p> <p>13 reviewed by peers, correct?</p> <p>14 MS. O'DELL: Object to form.</p> <p>15 A. Correct, yes.</p> <p>16 BY MR. FERGUSON:</p> <p>17 Q. Now, in your report that you did in this</p> <p>18 case, and I know it's been marked as an exhibit. I</p> <p>19 forget which number. In your report in this case, you</p> <p>20 have, among other authorities, cited Dr. Longo and</p> <p>21 Dr. Rigler's report, correct?</p> <p>22 A. I've cited expert witness reports, yes.</p> <p>23 Q. And you understand that Dr. Longo and</p> <p>24 Rigler's report, that's not peer reviewed, correct? You</p> <p>25 understand that?</p>
<p style="text-align: right;">Page 283</p> <p>1 (A recess was taken from 6:19 to 6:33.)</p> <p>2 VIDEOGRAPHER: We are now back on record,</p> <p>3 and the time is 6:33.</p> <p>4 CROSS-EXAMINATION</p> <p>5 BY MR. FERGUSON:</p> <p>6 Q. Good evening, Dr. Krekeler. How are you?</p> <p>7 A. Good.</p> <p>8 Q. Okay. We met briefly before. My name is</p> <p>9 Ken Ferguson, and I represent Imerys. Do you understand</p> <p>10 that?</p> <p>11 A. Yes.</p> <p>12 Q. Okay. And I've got, along with Mr. Cary,</p> <p>13 who's down, three people down from me.</p> <p>14 A. Okay.</p> <p>15 Q. I've got some questions for you. I'm not</p> <p>16 going to spend a lot of time, because there's not a lot</p> <p>17 of time left, so I may skip around a little, just</p> <p>18 depending on which questions I feel like I need to get</p> <p>19 asked before I run out of time. So I'm not trying to</p> <p>20 confuse you by that, but if I do, then you let me know,</p> <p>21 and I'll restate the question, okay?</p> <p>22 A. Okay.</p> <p>23 Q. Okay. Fair enough.</p> <p>24 So in your career as an academic, you've</p> <p>25 written scientific papers before, correct?</p>	<p style="text-align: right;">Page 285</p> <p>1 A. Yes, I do.</p> <p>2 Q. So while your custom is to cite</p> <p>3 peer-reviewed articles in your scientific papers that</p> <p>4 you're writing, you've varied from that in doing your</p> <p>5 report here in this matter, correct?</p> <p>6 MS. O'DELL: Object to the form.</p> <p>7 A. Yes. So I have not in my previous work</p> <p>8 cited an expert witness report.</p> <p>9 BY MR. FERGUSON:</p> <p>10 Q. And you understand that Dr. Longo and his</p> <p>11 colleague, Dr. Rigler, and I think they wrote these</p> <p>12 reports together, that they are being paid as experts by</p> <p>13 counsel for plaintiffs just as you are, correct?</p> <p>14 MS. SCOTT: Objection.</p> <p>15 A. I believe that is the case, yes.</p> <p>16 BY MR. FERGUSON:</p> <p>17 Q. I want to talk to you a little bit about</p> <p>18 a book that I see you've got your copy out. I've got my</p> <p>19 copy out, and we have some copies we've made that I'm</p> <p>20 going to mark as Exhibit 23, I believe.</p> <p>21 (Exhibit 23 was marked for</p> <p>22 identification.)</p> <p>23 BY MR. FERGUSON:</p> <p>24 Q. Now what I've marked, Dr. Krekeler, are</p> <p>25 some pages from a book called "An Introduction to the</p>

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<p>1 Rock-Forming Minerals" by Deer, Howie and Zussman, 2 correct? 3 A. Is this the same edition? 4 Q. I believe -- I believe it's the third 5 edition. 6 A. Oh, I'm sorry. 7 Q. And yours is? 8 A. Third. Yeah, we're good. 9 Q. This is a book that is often relied upon 10 by mineralogists, correct, material scientists? 11 A. This is a book that is used as a textbook 12 for mineralogy courses, yes. 13 Q. So let's go back to your report, and if 14 you would, just keep the Deer, Howie and Zussman by your 15 side. Go to your report at page 5. Are you with me? 16 A. Page 5. 17 Q. And in the first paragraph on page 5 of 18 your report, there's a sentence in the middle that says, 19 "As a result, natural talc formation is commonly 20 accompanied by veins of other minerals, including 21 asbestiform minerals like tremolite and serpentine," 22 correct? 23 A. Yes. 24 Q. And you cite for that Deer, Howie & 25 Zussman 2013, correct?</p>	<p>1 (Exhibit 24 was marked for 2 identification.) 3 BY MR. FERGUSON: 4 Q. And this is a paper by a Harold R. 5 Newman, correct? 6 A. That's what it says. 7 Q. And it says, "The Mineral Industry of 8 Italy," correct? 9 A. Yes. What journal did this come from? 10 Is this peer review? 11 Q. I don't know. I believe it is, but I 12 don't know the answer, so I'm not going to answer it. 13 A. You believe or it is? 14 Q. I get to ask the questions. 15 A. All right. 16 Q. We have Harold Newman's paper here, okay? 17 A. Okay. 18 Q. From The Mineral Institute of Italy, 19 right? 20 A. Mineral Industry of Italy, one. 21 Q. So look at page -- 22 A. I'm sorry? 23 Q. Look at page 428, please. 24 A. 428? 25 Q. Yes. And you see on the right-hand</p>
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<p>1 A. Yep. 2 Q. And the citation down below cites, for 3 that assertion, pages 145, 149, 151 and 164 to 165, 4 correct? 5 A. Yes. That's what it reads. 6 Q. And it's your contention in your expert 7 report that those pages stand for the proposition that 8 we just read the "natural talc formation is commonly 9 accompanied by veins of other minerals, including 10 asbestiform minerals like tremolite and serpentine," 11 correct? 12 A. Yes. 13 Q. Let's move on because I'm not sure I have 14 it time to sit and read them all now. Let's move on to 15 another topic. Let's look at page 9 of your report, 16 please. 17 A. Page 9? 18 Q. Page 9, sir, yes. And do you see on page 19 9 that you have said in the -- I think it's the second 20 full paragraph. "Based on what I have reviewed, I have 21 sufficient basis to conclude that Italian ore was of 22 poor quality," correct? 23 A. Yes. 24 Q. And let me show you, first of all, an 25 exhibit that we'll mark as Exhibit 24.</p>	<p>1 column, this is a paragraph that has "Talc" in bold at 2 the beginning of the paragraph, correct? 3 A. Correct. 4 Q. And it says -- and I won't try to 5 pronounce the Italian names. We had enough trouble with 6 Chinese names earlier on, but "Talco" -- I'll try -- "e 7 Grafite Val Chisone S.p.A. operated two underground 8 mines at Pinerolo near Turin," correct? 9 A. That is what it says. I didn't know. 10 Q. And next sentence says, "The white talc, 11 mined from metamorphic rocks, has been of very high 12 quality," correct? 13 A. That is what it says. It doesn't say 14 what high quality for. Is it -- the table in the back, 15 does it say what the talc is used for? Talc and related 16 materials. It just lists tonnages. 17 MR. FERGUSON: And I'd like the next 18 list, Exhibit 24 -- 25. My bad. 19 (Exhibit 25 was marked for 20 identification.) 21 BY MR. FERGUSON: 22 Q. The first author is Edward B. Ilgren, 23 I-l-g-r-e-n, correct? 24 A. Ilgren, yes. 25 Q. And the title is "Analysis of an</p>

<p style="text-align: right;">Page 290</p> <p>1 Authentic Historical Italian Cosmetic Talc Sample</p> <p>2 Further Evidence for the Lack of Cancer Risk," correct?</p> <p>3 A. And analysis of an, implying one,</p> <p>4 authentic historical Italian. Yes, that's what the</p> <p>5 title is.</p> <p>6 Q. Exactly. It does say "an," a-n?</p> <p>7 A. A single or it's implied that's a single</p> <p>8 sample. I have not seen this paper before.</p> <p>9 Q. Can you look with me at the first line of</p> <p>10 the abstract, where it says, "Italian talc from the</p> <p>11 Pinerolo Mines in northwest Italy is known for its</p> <p>12 extreme purity," correct?</p> <p>13 A. That is what it says. It doesn't say</p> <p>14 with respect to what, so and then -- so it's an</p> <p>15 abstract. It should be a summary from introductory</p> <p>16 materials, so let's see if they discuss that in the</p> <p>17 introduction. "It is known for its extreme purity.</p> <p>18 More than 60 years of epidemiological studies have</p> <p>19 failed to demonstrate any attendant cancer risk." So --</p> <p>20 Q. I don't need you to read it out loud. I</p> <p>21 apologize for interrupting. Obviously, time is limited.</p> <p>22 You've answered my question, so what we know is that</p> <p>23 Mr. Newman and Dr. Ilgren disagree with your comment</p> <p>24 that the Italian talc is not good quality, correct?</p> <p>25 MS. O'DELL: Object to the form.</p>	<p style="text-align: right;">Page 292</p> <p>1 about his report while you're pulling that up,</p> <p>2 if you wouldn't mind?</p> <p>3 MS. O'DELL: Yeah, sure. I've got it</p> <p>4 right here.</p> <p>5 BY MR. FERGUSON:</p> <p>6 Q. Could look at page 31 of your report,</p> <p>7 Dr. Krekeler?</p> <p>8 A. I'm at page 31.</p> <p>9 Q. Are you with me, sir? Okay. Just above</p> <p>10 the heading of "Toxic Metal Contamination," is a</p> <p>11 paragraph that starts "In summary." And do you see a</p> <p>12 sentence there that says, "Defendants admit that the</p> <p>13 beneficiation process does not remove asbestos"? Do you</p> <p>14 see that sentence?</p> <p>15 A. I do see that sentence.</p> <p>16 Q. And for that proposition, you cite the</p> <p>17 deposition of Patrick Downey at page 407, pages -- line.</p> <p>18 Excuse me. Lines 13 through 16, correct? That's what</p> <p>19 you cited?</p> <p>20 A. Correct.</p> <p>21 Q. All right. Let's look, if we may, look</p> <p>22 at Exhibit 26, and the second -- the first page of that</p> <p>23 is just the cover page to Mr. Downey's deposition.</p> <p>24 Could you turn to the second page, and let's look at</p> <p>25 page 407, lines 13 to 16, which you cited.</p>
<p style="text-align: right;">Page 291</p> <p>1 A. They can disagree, correct.</p> <p>2 BY MS. ROSE:</p> <p>3 Q. At one point in your report on page 13,</p> <p>4 you say that, "Usually, companies have a dedicated</p> <p>5 in-house laboratory for these analyses."</p> <p>6 A. Yes. Oil Dry as an example. There's</p> <p>7 other companies that have, you know, extensive labs, and</p> <p>8 also, people rely on third-party labs to check their</p> <p>9 internal labs.</p> <p>10 Q. And you're aware that Imerys has had and</p> <p>11 has a dedicated in-house laboratory as well, correct?</p> <p>12 A. I believe so, yes.</p> <p>13 Q. And, in addition, Imerys has had occasion</p> <p>14 to send samples to third-party laboratories as well,</p> <p>15 correct?</p> <p>16 A. Correct.</p> <p>17 Q. Let me mark for you Exhibit 26 to your</p> <p>18 deposition, please.</p> <p>19 (Exhibit 26 was marked for</p> <p>20 identification.)</p> <p>21 MS. O'DELL: Let me get that out here.</p> <p>22 MR. FERGUSON: Sure. No problem. Let me</p> <p>23 know when you're ready.</p> <p>24 MS. O'DELL: Yeah. Okay.</p> <p>25 MR. FERGUSON: Can I ask him a question</p>	<p style="text-align: right;">Page 293</p> <p>1 A. So 407?</p> <p>2 Q. Yes, sir.</p> <p>3 A. 13 to 16. Can I have a moment to read</p> <p>4 the context above it and stuff?</p> <p>5 Q. Certainly, sir.</p> <p>6 A. To refresh my memory?</p> <p>7 Q. Certainly, sir. Ready to go? Got the</p> <p>8 context?</p> <p>9 A. Yes.</p> <p>10 Q. All right. So if we look at lines 13</p> <p>11 through 16, that is an answer by Mr. Downey where he</p> <p>12 says, "I don't know if -- I'm not familiar, and I don't</p> <p>13 know if flotation was intended to remove asbestos, but</p> <p>14 to my knowledge, our products don't contain asbestos</p> <p>15 so." Did I read that correctly?</p> <p>16 A. Yes, you did read that correctly.</p> <p>17 Q. So, in fact, Mr. Downey is not, as you</p> <p>18 say, admitting that the beneficiation process does not</p> <p>19 remove asbestos. Instead, what he says is I don't know</p> <p>20 if flotation was intended to remove asbestos, correct?</p> <p>21 A. That's what it says. I took it as -- he</p> <p>22 said "I don't know" twice, "I'm not familiar." And it</p> <p>23 says, "I don't know if flotation was intended to remove</p> <p>24 asbestos." So the text is correct, yes.</p> <p>25 Q. But you would agree he did not admit that</p>

<p style="text-align: right;">Page 294</p> <p>1 the beneficiation process does not remove asbestos, 2 correct?</p> <p>3 MS. SCOTT: Objection.</p> <p>4 A. He doesn't know if it was intended or not 5 is how -- that's how I interpret it. Others can 6 interpret it in other ways.</p> <p>7 BY MR. FERGUSON:</p> <p>8 Q. Would you look at the bottom of page 31, 9 please, of your report?</p> <p>10 A. Okay. On page 31. I see it, yes.</p> <p>11 Q. And you see it says, at the bottom, it 12 starts a sentence, "In fact, these chemical elements are 13 inherent properties of talc ore, a fact acknowledged by 14 Julie Pier in her deposition." And then you cite Julie 15 Pier Deposition, page 211, lines six through 13 from the 16 September 12, 2018, session of her deposition. Do you 17 see that?</p> <p>18 A. Yes, I do.</p> <p>19 Q. And could you go to your left and pick up 20 Miss Pier's deposition? And both sessions are there. 21 If you could, look at the -- they're in reverse order, I 22 noticed before, so would you look at the deposition that 23 is the second one in that notebook? It's the second 24 one. It's not the first one because they're in reverse 25 order. That's the September 13 session, I notice, and</p>	<p style="text-align: right;">Page 296</p> <p>1 A. I have -- "I have just a general broad 2 understanding that as it's crushed, an automatic sampler 3 takes a sample at specific time intervals." That's 4 through line 13.</p> <p>5 Q. All right. So would you agree with me 6 that in that portion of the deposition, Ms. Pier does 7 not acknowledge the fact that chemical elements are 8 inherent properties of talc ore, correct?</p> <p>9 A. Correct.</p> <p>10 Q. It doesn't say that at all, does it?</p> <p>11 A. Yeah. I must have made a mistake with 12 the numbering.</p> <p>13 Q. You also state in your report that Imerys 14 admitted in depositions that -- well, let me skip back 15 because I don't have my citation. So let's -- let's 16 move on to another topic. I may come back to that if I 17 have time, okay?</p> <p>18 A. Right. Do you want me to put the Pier 19 deposition away?</p> <p>20 Q. Yeah, for now.</p> <p>21 A. I'll set it aside.</p> <p>22 Q. Yeah. Keep it handy in case we have time 23 to get back to that.</p> <p>24 A. Okay.</p> <p>25 Q. Now, you have taken, as you -- as we</p>
<p style="text-align: right;">Page 295</p> <p>1 you can go all the way past those. There you go.</p> <p>2 A. I'll try not to break the stuff.</p> <p>3 Q. Can we look at page --</p> <p>4 A. You said -- is it 211?</p> <p>5 Q. Yes, sir. Page 211, please, sir.</p> <p>6 A. I turned right to it. 211.</p> <p>7 Q. Okay.</p> <p>8 A. And you're interested in lines 6 through 9 13? Is that your question?</p> <p>10 Q. Right. And what you've asserted is 11 that -- you cite that for the proposition, "In fact, 12 these chemical elements are inherit properties of talc 13 ore, a fact acknowledged by Julie Pier."</p> <p>14 Can you read for me page 211, Lines 6 15 through 13 of the September 12 deposition?</p> <p>16 A. Well, this has to do -- can I first read 17 the context a little bit to refresh myself?</p> <p>18 Q. Right now, I'd like you to read what --</p> <p>19 A. Okay. I can just read the text.</p> <p>20 Q. Yeah, what you cited.</p> <p>21 A. "Well, this has to do with sampling 22 that's done at the operation. I'm thinking that Pat is 23 in -- If you don't know, you can tell me that." 24 Question. "I'm" -- dash dash dash or -- "..." 25 Q. Are you past line --</p>	<p style="text-align: right;">Page 297</p> <p>1 discussed earlier, you have taken the report of 2 Drs. Longo and Rigler and relied upon it for your 3 report, correct?</p> <p>4 A. Correct.</p> <p>5 Q. And that has to do with whether there are 6 contaminants in talc that is sold by Imerys and by 7 Johnson & Johnson, correct? That's what they addressed?</p> <p>8 A. Correct.</p> <p>9 Q. Now, are you an aware, Dr. Krekeler, that 10 the United States Food & Drug Administration actually 11 performed a survey of talc and body powders and cosmetic 12 raw material talc?</p> <p>13 A. I believe so. I looked at an FDA 14 document on the Internet, and if I remember correctly -- 15 I would want to check -- there was four suppliers that 16 provided talc products, and they did not find any 17 indications or it was nondetects for those many samples. 18 But I also remember that the FDA also said that -- I'd 19 have to look at it for the exact language, but, 20 essentially, the FDA couldn't fully assure that talc is 21 free of asbestos, I think. Do you have that?</p> <p>22 MR. FERGUSON: Yeah. Let's go ahead and 23 mark as Exhibit 27 the FDA survey. 24 (Exhibit 27 was marked for 25 identification.)</p>

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<p>1 A. I don't know if it's exactly the same one</p> <p>2 that I looked at.</p> <p>3 MR. BILLINGS-KANG: Ken, was the Pier</p> <p>4 deposition marked at all?</p> <p>5 MR. FERGUSON: No. I didn't mark it. I</p> <p>6 can mark it.</p> <p>7 MS. SCOTT: 27?</p> <p>8 MR. FERGUSON: Yes.</p> <p>9 A. It's a printed, so it looks like a</p> <p>10 different format than maybe the one I looked at. The</p> <p>11 tables look familiar.</p> <p>12 BY MR. FERGUSON:</p> <p>13 Q. So since our time is growing short, if</p> <p>14 you would, it looks familiar?</p> <p>15 A. Okay. Yeah. I -- I do think it's the</p> <p>16 one I looked at, I think.</p> <p>17 Q. Go to the second page of the exhibit, and</p> <p>18 you see that it has a heading and a little chart saying</p> <p>19 "Cosmetic-grade raw material talc," correct?</p> <p>20 A. The second page, the heading is "How FDA</p> <p>21 followed up on the latest"?</p> <p>22 Q. Yeah. If you go to the bottom, there's a</p> <p>23 little chart with a heading that says, "Cosmetic-grade</p> <p>24 raw material talc," correct?</p> <p>25 A. Yes.</p>	<p>1 Q. Let's call it rows.</p> <p>2 A. Oh, rows. Okay. All right.</p> <p>3 Q. Okay.</p> <p>4 A. So for these seven rows, yes.</p> <p>5 Q. Okay.</p> <p>6 A. There's no asbestos detected for those</p> <p>7 seven samples.</p> <p>8 Q. Okay. And if we go to the</p> <p>9 second-to-the-last page of that exhibit -- in fact, it's</p> <p>10 the last page that has typing on it.</p> <p>11 A. The second-to-the-last page.</p> <p>12 Q. Are you there?</p> <p>13 A. Okay.</p> <p>14 Q. Do you see there's a column that is or a</p> <p>15 chart that is entitled "Body Powder," correct?</p> <p>16 A. Correct.</p> <p>17 Q. And there's a line, a row for Johnson's</p> <p>18 Baby Powder, correct?</p> <p>19 A. Correct.</p> <p>20 Q. That says no asbestos detected by PLM or</p> <p>21 by TEM, correct?</p> <p>22 A. Correct.</p> <p>23 Q. And a row for Shower or Shower, Morning</p> <p>24 Fresh Absorbent Body Powder that likewise says no</p> <p>25 asbestos detected by PLM and TEM, correct?</p>
Page 299	Page 301
<p>1 Q. And you see under "Supplier," it says,</p> <p>2 "Rio Tinto Minerals/Luzenac America," correct?</p> <p>3 A. Correct.</p> <p>4 Q. And if you look at that and the next</p> <p>5 page, there are seven lots that were tested from Rio</p> <p>6 Tinto Minerals/Luzenac America, correct?</p> <p>7 A. One, two, three, four. Yes. Seven?</p> <p>8 Q. Yes, sir.</p> <p>9 A. From Rio Tinto.</p> <p>10 Q. Okay. And there's a column for</p> <p>11 "Percentage Asbestos by PLM." That's polarized light</p> <p>12 microscopy, correct?</p> <p>13 A. Yes. There's a column for that.</p> <p>14 Q. And there's a percentage asbestos by TEM</p> <p>15 or transmission electron microscope, correct?</p> <p>16 A. Yes. There's a column for that.</p> <p>17 Q. Okay. And in all 14 columns, it notes no</p> <p>18 asbestos detected, correct?</p> <p>19 MS. O'DELL: Objection.</p> <p>20 A. Fourteen columns?</p> <p>21 BY MS. ROSE:</p> <p>22 Q. Well, there's seven for PLM, seven for</p> <p>23 TEM?</p> <p>24 A. Oh, you mean rows or 14 columns? One,</p> <p>25 two, three, four, five columns.</p>	<p>1 A. At the very bottom, yes.</p> <p>2 Q. So in this Food & Drug Administration</p> <p>3 survey that was done, the results were different than</p> <p>4 the ones that Drs. Longo and Rigler came up with,</p> <p>5 correct?</p> <p>6 MS. O'DELL: Object to the form.</p> <p>7 A. Well, it's not the same sample size.</p> <p>8 And, yeah, this is the same report. As it says, "For</p> <p>9 these reasons, while FDA finds these results</p> <p>10 informative, they do not prove that most or all talc or</p> <p>11 talc-containing cosmetic products currently marketed in</p> <p>12 the United States are likely to be free of asbestos</p> <p>13 contamination. As always, when potential" -- yeah.</p> <p>14 This is, yeah. This is the, yeah.</p> <p>15 BY MS. ROSE:</p> <p>16 Q. But we know that they tested Luzenac, raw</p> <p>17 material talc and Johnson & Johnson body powder,</p> <p>18 correct?</p> <p>19 A. Correct. Yes.</p> <p>20 MR. FERGUSON: What are we doing on time,</p> <p>21 if you wouldn't mind letting me know?</p> <p>22 VIDEOGRAPHER: You've been on record six</p> <p>23 hours and 51 minutes.</p> <p>24 MR. FERGUSON: I've got a few minutes.</p> <p>25 MR. BILLINGS-KANG: Plenty of time.</p>

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<p>1 MR. FERGUSON: Plenty of time.</p> <p>2 THE WITNESS: Are we done with this one?</p> <p>3 MR. FERGUSON: Yes, sir. We're done with</p> <p>4 that one.</p> <p>5 BY MS. ROSE:</p> <p>6 Q. Let me ask you one more area, one more</p> <p>7 area, and then I'll quit.</p> <p>8 MR. BILLINGS-KANG: I'm going to give him</p> <p>9 my time.</p> <p>10 MR. FERGUSON: Okay.</p> <p>11 MR. CARY: Time for the gentleman from</p> <p>12 Texas.</p> <p>13 MS. O'DELL: It's like we're in the</p> <p>14 Senate or House.</p> <p>15 MR. FERGUSON: The House. I hope not.</p> <p>16 MR. FROST: Won't do too well for that.</p> <p>17 MS. SCOTT: I was just going to say the</p> <p>18 same thing.</p> <p>19 BY MR. FERGUSON:</p> <p>20 Q. Could you get the IARC 93 monograph,</p> <p>21 which I believe is Exhibit 5?</p> <p>22 A. IARC 93. IARC 93. Yep. Exhibit 5, yes.</p> <p>23 Q. All right.</p> <p>24 MR. FERGUSON: And I'm sorry, Leigh and</p> <p>25 Carmen, do you guys have? Okay.</p>	<p>1 jet mills and are classified and separated from other</p> <p>2 minerals by froth flotation or magnetic separation,"</p> <p>3 correct?</p> <p>4 A. Yes. And there's no citation for that.</p> <p>5 Q. And the IARC working group does note that</p> <p>6 the techniques by which top ores may be processed</p> <p>7 include hand sorting, correct?</p> <p>8 A. Correct, yes. That's in the second line</p> <p>9 on the paragraph. That's what they say. Again, it's</p> <p>10 not cited, so I'm not sure where they get the</p> <p>11 information from, but they say that.</p> <p>12 MR. FERGUSON: Can we go off for one</p> <p>13 second? I know we're almost done, please.</p> <p>14 VIDEOGRAPHER: We're now going off</p> <p>15 record. The time is 7:05.</p> <p>16 (Off the record.)</p> <p>17 VIDEOGRAPHER: We are now back on record.</p> <p>18 The time is 7:07.</p> <p>19 BY MR. FERGUSON:</p> <p>20 Q. Dr. Krekeler, could you turn to page 42</p> <p>21 of your report?</p> <p>22 A. 42 of my report?</p> <p>23 Q. Yes, sir.</p> <p>24 A. 42.</p> <p>25 Q. Not of the IARC.</p>
Page 303	Page 305
<p>1 MS. O'DELL: What page?</p> <p>2 MR. FERGUSON: I am going to be looking</p> <p>3 at page 286.</p> <p>4 BY MR. FERGUSON:</p> <p>5 Q. Can you find page 286?</p> <p>6 A. 286. 285, 286. I found it.</p> <p>7 Q. At the top of page 286, the section --</p> <p>8 and, again, this is from the IARC monograph, correct?</p> <p>9 A. Correct.</p> <p>10 Q. That you discussed earlier and you've</p> <p>11 cited in your report, correct?</p> <p>12 MS. O'DELL: Objection. Cites the</p> <p>13 monograph, but you're saying he cites this.</p> <p>14 It's a little confusing.</p> <p>15 MR. FERGUSON: I apologize.</p> <p>16 BY MR. FERGUSON:</p> <p>17 Q. You've cited this monograph, not</p> <p>18 necessarily this portion of it?</p> <p>19 A. Correct. Yeah. I've cited the</p> <p>20 monograph.</p> <p>21 Q. So let's look at the first paragraph</p> <p>22 there on page 286. You see it says, "Talc ores may be</p> <p>23 processed by a variety of techniques that include</p> <p>24 selective mining, hand sorting and milling by roller</p> <p>25 mills, hammer mills, ball mills, fluid energy mills and</p>	<p>1 A. Oh, I thought we were still talking about</p> <p>2 that. I'm sorry.</p> <p>3 Q. No. I apologize. Of your report?</p> <p>4 A. Okay.</p> <p>5 Q. Okay?</p> <p>6 A. Yep.</p> <p>7 Q. Are you there?</p> <p>8 A. Yes.</p> <p>9 Q. Okay. So if you look at the last</p> <p>10 paragraph on page 42 about --</p> <p>11 A. Grinding?</p> <p>12 Q. That paragraph.</p> <p>13 A. Yep.</p> <p>14 Q. But if you look at the fifth line of</p> <p>15 that, you see where it starts, "Imerys admitted," and it</p> <p>16 goes on to say, "Imerys admitted, in deposition, that a</p> <p>17 phyllosilicate sample could be ground to a near</p> <p>18 amorphous state, damaging the sample, even with minimal</p> <p>19 grinding." Correct? Did I read that correctly?</p> <p>20 A. Yes. That is correct.</p> <p>21 Q. And then you cite the Julie Pier</p> <p>22 deposition, page 25, 23 to 25, and page 26, 1 through</p> <p>23 23, September 23rd, 2018? Correct?</p> <p>24 A. Correct.</p> <p>25 Q. And so would you pick up again the Julie</p>

<p style="text-align: right;">Page 306</p> <p>1 Pier notebook to your left? And this time, we're</p> <p>2 looking at the first deposition in the notebook because</p> <p>3 they're reversed, and that's the September 13th, 2018,</p> <p>4 date. So would you turn to page 25 in that</p> <p>5 deposition --</p> <p>6 A. This starts at page 340.</p> <p>7 Q. Yes, it does.</p> <p>8 A. So page --</p> <p>9 Q. Would you with agree with me there is no</p> <p>10 page 25 and no page 26 in the Julie Pier deposition</p> <p>11 transcript from September 13th, 2018?</p> <p>12 A. I don't know.</p> <p>13 Q. Well --</p> <p>14 A. Let's look and see.</p> <p>15 Q. You have the deposition transcript in</p> <p>16 front of you, sir.</p> <p>17 A. Is that -- I don't remember if it's a one</p> <p>18 or two volume. Some of these, I think, were two volume.</p> <p>19 Q. Well, sir --</p> <p>20 A. So I think if -- yeah, I don't remember</p> <p>21 specifically, but if this is --</p> <p>22 Q. Why don't you look at the very first</p> <p>23 page.</p> <p>24 A. The first page says 340. This is the</p> <p>25 page number.</p>	<p style="text-align: right;">Page 308</p> <p>1 Q. Well, those pages weren't missing. The</p> <p>2 words that you quoted were not just not on them,</p> <p>3 correct?</p> <p>4 MS. SCOTT: Objection.</p> <p>5 A. It's unclear.</p> <p>6 BY MR. FERGUSON:</p> <p>7 Q. Do you think maybe this is another</p> <p>8 mistake or typo?</p> <p>9 A. I don't know.</p> <p>10 MR. FERGUSON: That's all I have,</p> <p>11 Dr. Krekeler. Thank you for your time, sir.</p> <p>12 VIDEOGRAPHER: Do you want to go off?</p> <p>13 MS. O'DELL: James, are you okay?</p> <p>14 MR. BILLINGS-KANG: I'm fine. Thank you.</p> <p>15 MS. O'DELL: How much time on the record?</p> <p>16 VIDEOGRAPHER: Seven hours even.</p> <p>17 MS. O'DELL: Let's go take a break.</p> <p>18 MR. FROST: Look at that.</p> <p>19 VIDEOGRAPHER: We are going off record.</p> <p>20 The time is 7:13.</p> <p>21 (A recess was taken from 7:13 to 7:47.)</p> <p>22 VIDEOGRAPHER: We are now back on record.</p> <p>23 The time is 7:47.</p> <p>24 EXAMINATION</p> <p>25</p>
<p style="text-align: right;">Page 307</p> <p>1 Q. Look at the very first page there that</p> <p>2 you're looking at there, and does that say Julie Pier's</p> <p>3 deposition from September 13th of 2018?</p> <p>4 A. Actually, on this page, there is not --</p> <p>5 oh, September 13th, 2018.</p> <p>6 Q. And just as you told us, there is no page</p> <p>7 25 or page 26 for the September 13, 2018, deposition of</p> <p>8 Julie Pier, is there?</p> <p>9 A. In this printed copy, there appears not</p> <p>10 to be. I don't --</p> <p>11 Q. So --</p> <p>12 A. Can I check to see if it's confused by --</p> <p>13 just double-check? I might have.</p> <p>14 Q. Do you want to check the September 12th</p> <p>15 version and see?</p> <p>16 A. Yeah. I don't know if I've confused</p> <p>17 things or not. So we're looking at --</p> <p>18 Q. Page 25 and page 26.</p> <p>19 A. 25 and 26.</p> <p>20 Q. She is not talking about phyllosilicates</p> <p>21 on pages 25 or 26 of the September 12th, is she?</p> <p>22 A. Correct. I currently don't have an</p> <p>23 explanation for the apparent discrepancy.</p> <p>24 Q. Do you think since --</p> <p>25 A. I don't know if pages are missing or...</p>	<p style="text-align: right;">Page 309</p> <p>1 BY MS. O'DELL:</p> <p>2 Q. Dr. Krekeler, good evening. I've got a</p> <p>3 few questions for you to follow up.</p> <p>4 A. Okay.</p> <p>5 Q. First, you were asked a number of</p> <p>6 questions about Italian talc and the talc ore deposits</p> <p>7 in Italy. Do you recall those questions?</p> <p>8 A. Generally, yes.</p> <p>9 Q. And, in fact, you were handed a binder of</p> <p>10 a documents that I think are in front of you now that --</p> <p>11 they were marked as Exhibit 14.</p> <p>12 A. Exhibit -- yes.</p> <p>13 Q. And they related to certain documents</p> <p>14 regarding talc formations in Italy. Do you recall those</p> <p>15 documents?</p> <p>16 A. Correct.</p> <p>17 Q. And specifically in terms of the Italian</p> <p>18 ore bodies, were there positive tests of asbestos in</p> <p>19 Italian talc that you reviewed in reaching your opinions</p> <p>20 in this case?</p> <p>21 MR. FROST: Objection to form.</p> <p>22 A. Yes.</p> <p>23 BY MS. O'DELL:</p> <p>24 Q. And, in fact, if you'll turn to page -- I</p> <p>25 think it was 14 of your report. Do you see that?</p>

<p style="text-align: right;">Page 310</p> <p>1 A. Yes.</p> <p>2 Q. And are the test results depicted on page</p> <p>3 14 -- well, let me just ask you this way. Where did the</p> <p>4 test results depicted in the table on page 14 of your</p> <p>5 expert report, where did they originate from?</p> <p>6 A. There are five examples from 1957 to '58</p> <p>7 from Italy.</p> <p>8 Q. And you were also handed by Mr. Ferguson</p> <p>9 what's been marked as Exhibit 25. I don't recall if you</p> <p>10 recall a document entitled, "Analysis of an Authentic</p> <p>11 Historical --</p> <p>12 A. Yes.</p> <p>13 Q. -- "Italian Cosmetic Talc Sample." Do</p> <p>14 you recall that?</p> <p>15 A. Yep.</p> <p>16 Q. Do you have it in front of you?</p> <p>17 A. Yes.</p> <p>18 Q. And Mr. Ferguson asked you to read the</p> <p>19 first sentence of the abstract which addressed "the</p> <p>20 extreme purity" of Italian talc. Do you recall that?</p> <p>21 A. Correct. Yes, I do.</p> <p>22 Q. Did this report that's been marked as</p> <p>23 Exhibit 5 actually report the presence of tremolite</p> <p>24 fibers in Italian talc?</p> <p>25 A. Yes. There's -- it reports the numerical</p>	<p style="text-align: right;">Page 312</p> <p>1 BY MS. O'DELL:</p> <p>2 Q. In fact, at the top, in the first full</p> <p>3 paragraph, it says, "The TEM micrograph in Figure B1</p> <p>4 shows a number of platy talc particles. Figure B-2</p> <p>5 shows platy talc particles and an elongated fragment of</p> <p>6 talc."</p> <p>7 A. Of talc. Two -- yeah. "Two other</p> <p>8 tremolite fibers were detected," and then it restates</p> <p>9 that numerical concentration of tremolite fibers in talc</p> <p>10 was the number that I mentioned previously.</p> <p>11 BY MS. O'DELL:</p> <p>12 Q. And so does, in fact, Exhibit 25 support</p> <p>13 your opinion that Italian talc is contaminated with</p> <p>14 asbestos?</p> <p>15 MR. BILLINGS-KANG: Objection to form.</p> <p>16 MR. FROST: Objection to form.</p> <p>17 BY MS. O'DELL:</p> <p>18 Q. Now, let me ask you to turn to your</p> <p>19 report specifically. Oh, one question. You were asked</p> <p>20 a few questions today about the beneficiation process,</p> <p>21 and if there is asbestos fibers present in talc ore, is</p> <p>22 there anything in the beneficiation process that you</p> <p>23 would expect to remove the asbestos fibers from the</p> <p>24 talc?</p> <p>25 A. Not efficiently.</p>
<p style="text-align: right;">Page 311</p> <p>1 concentration of tremolite fibers in the talc sample was</p> <p>2 3.67 -- 3.687 times 10 to the negative 6 fibers per</p> <p>3 gram, so that is over 3 million fibers per gram</p> <p>4 corresponding to a mass concentration of .722 parts per</p> <p>5 million.</p> <p>6 Q. And if you'll turn to page 3 of this</p> <p>7 exhibit --</p> <p>8 MR. FROST: Leigh, what exhibit is this?</p> <p>9 MS. O'DELL: 25.</p> <p>10 MR. FROST: 25. Okay.</p> <p>11 MS. O'DELL: It's what Ken marked.</p> <p>12 MR. FROST: Oh, I thought you said five.</p> <p>13 I apologize.</p> <p>14 MS. O'DELL: Did I? Sorry. Thank you.</p> <p>15 MR. BILLINGS-KANG: You said five.</p> <p>16 MS. O'DELL: I don't think you heard the</p> <p>17 two, but 25 is what I'm referring to.</p> <p>18 MR. FROST: Thank you.</p> <p>19 BY MS. O'DELL:</p> <p>20 Q. On page 3 of the exhibit, Dr. Krekeler,</p> <p>21 did the authors of this report also report the presence</p> <p>22 of fibrous talc in this particular sample?</p> <p>23 MR. BILLINGS-KANG: Object to form.</p> <p>24 A. Yes. I believe I saw it in here.</p> <p>25</p>	<p style="text-align: right;">Page 313</p> <p>1 Q. Let me ask you to turn to page 35 of your</p> <p>2 report. Actually, 36.</p> <p>3 A. Okay. I'm on page 36.</p> <p>4 Q. And, actually, you can look at, actually,</p> <p>5 either 35 or 36, but are the test results and the</p> <p>6 samples that are of the samples reported in the table on</p> <p>7 page 35, and do many of them include the results of</p> <p>8 annual composite samples?</p> <p>9 A. Yes.</p> <p>10 Q. And are -- what are annual composite</p> <p>11 samples?</p> <p>12 A. They are, essentially, talcum powder</p> <p>13 that's ready to go as a consumer product, essentially a</p> <p>14 consumer product.</p> <p>15 Q. And annual samples would be composed of</p> <p>16 processed talc?</p> <p>17 A. Yes.</p> <p>18 Q. And let me ask you to look at page 36,</p> <p>19 where you report some of the findings regarding</p> <p>20 chromium. Did Johnson & Johnson conduct testing of its</p> <p>21 talc powder that was specific enough to identify whether</p> <p>22 the type of chromium contained was either hexavalent</p> <p>23 chromium or trivalent chromium?</p> <p>24 MR. BILLINGS-KANG: Objection to form.</p> <p>25 MR. FROST: Objection to form.</p>

<p style="text-align: right;">Page 314</p> <p>1 A. No. I saw no evidence of any testing to 2 determine whether chromium was in the three-plus state 3 or the six-plus state. 4 MR. FROST: Move to strike the response 5 as speculative. 6 BY MS. O'DELL: 7 Q. Is that also true -- is that also true of 8 the testing that was conducted by Imerys? 9 MR. FROST: Objection to form. 10 A. I'm sorry. Can you repeat the question? 11 BY MS. O'DELL: 12 Q. Is that -- is that also true of the 13 testing that was conducted by Imerys regarding chromium? 14 MR. FROST: Same objection. 15 A. Yes. 16 BY MS. O'DELL: 17 Q. You were asked a number of questions 18 regarding the ore deposits in Vermont. Do you recall 19 those questions? 20 A. Yes. 21 Q. And you -- one of the exhibits that was 22 marked in regard to Vermont was the Ross commentary that 23 you cited, and I believe it's in front of you. What's 24 the exhibit number, please? 25 A. Twelve, I think.</p>	<p style="text-align: right;">Page 316</p> <p>1 geologic terrain. 2 Q. And in the comments that are included in 3 the Ross paper would cover the geologic formations that 4 were used to source Johnson & Johnson's talcum powder in 5 Vermont? 6 A. Yes. 7 MR. FROST: Objection to form. Calls for 8 speculation. 9 BY MS. O'DELL: 10 Q. Let me ask you to turn to Exhibit 11, 11 which should be right -- 12 A. Eleven. 13 Q. -- in front of you there. 14 A. Yes. 15 Q. And if you'll turn to page 2 of -- 16 A. Page 921 in the article? 17 Q. Yes. Let me ask you, with the 18 constituents of the geology, geologic formation that is 19 described in Ross, and we'll get to it, but, also, in 20 Van Gosen, would those constituents, as described in 21 those publications, be the same or similar to the mines 22 in Vermont that were used to source Johnson & Johnson's 23 talcum powder? 24 MR. FROST: Objection to form. 25 A. Yes.</p>
<p style="text-align: right;">Page 315</p> <p>1 Q. Okay. 2 A. That's correct. 3 Q. And Exhibit 12 was a reference that you 4 cited in your report? 5 A. Correct. 6 Q. And is the Ross commentary supportive of 7 your opinions? 8 A. Yes. 9 Q. Why? 10 A. So, essentially, end of second column, 11 "Ultramafic talc deposits of Vermont offer a third 12 example of the complexities of rock formations 13 containing asbestos minerals. The core of the 14 ultramafic bodies is off a serpentine rock derived from 15 a hydrothermal alteration of a pre-existing pyroxene and 16 olivine-rich ultramafic rock. The serpentine core often 17 grades outward into talc-serpentine-carbonate rock, then 18 steatite (massive talc ore containing often small 19 amounts of serpentine), then 'blackwall' rock (contains 20 amphiboles, chlorite, quartz, albite, et cetera), and 21 finally the country rock. Equivalent ultramafic bodies 22 in Quebec, Canada, form some of the world's largest 23 chrysotile deposits." 24 So, essentially, this is all the talc 25 mines are all part of this one essentially extensive</p>	<p style="text-align: right;">Page 317</p> <p>1 BY MS. O'DELL: 2 Q. Let me ask you to turn specifically to 3 Van Gosen, which we've marked as Exhibit 11 and 4 specifically ask you to turn to page 933. 5 A. Okay. Yes. 6 Q. Does page 933 begin a description of 7 Vermont talc? 8 A. Yes, it does. 9 Q. Does this description by Van Gosen apply 10 to the, or is it relevant to the geology of the talc 11 mines that were used to source J&J talc? 12 A. Yes, it is. 13 MR. FROST: Objection. Calls for 14 speculation. 15 BY MS. O'DELL: 16 Q. And if you'll turn to page 934, what is 17 the description of the Vermont talc geology that Van 18 Gosen includes in his article? 19 A. So, sorry. On the previous page, the 20 alteration of zones are typically compromised by 21 sequence, provides details -- 22 Q. Doctor, read more clearly for the court 23 reporter, please. 24 A. "Ultramafic rocks, grading to a 25 talc-carbonate-dominant zone, grading to a nearly</p>

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<p>1 mono-mineralogical ... zone," all these other rich 2 zones, Items 1 through 7. And then "Black-wall talc 3 deposits are associated spatially with serpentinite 4 masses that, in some areas, host well-developed 5 chrysotile asbestos." And there's citations from 1942 6 and '63. 7 BY MS. O'DELL: 8 Q. Okay. And did it also say that some of 9 the alteration zones contain actinolite, tremolite and 10 anthophyllite? 11 A. Yes. 12 Q. And does the Van Gosen article support 13 your opinions in this case? 14 MR. FROST: Objection. Calls for 15 speculation. 16 A. Yes. 17 BY MS. O'DELL: 18 Q. Let me ask you now to turn to Exhibit 15, 19 which also should be in front of you. 20 A. Fifteen. 21 Q. It's the Chidester -- 22 A. Fourteen. 23 Q. Fifteen. 24 A. Okay. 25 Q. So the Chidester article that was</p>	<p>1 A. I had it somewhere. Yeah, 18. Yes. 2 Q. And if you'll turn in Exhibit 18 to page 3 11, is this a document that you relied on in reaching 4 your opinions? 5 A. Yes. I'll get to page -- 6 Q. Page 11. 7 A. Page 11, "Elemental Scan" at the top. 8 Q. And does this page address the presence 9 of certain heavy metals in Chinese talc deposits? 10 A. Yes. 11 Q. And what metals specifically were 12 elevated? 13 A. Titanium. 14 Q. And based on this document, does the 15 writer include a comment below regarding the need to -- 16 well, let me just say for the writer's comments below 17 regarding the presence? 18 A. "This very sophisticated analysis shows a 19 relatively wide array of elements in subtrace levels. 20 Other high grade talcs can show a similar array. The 21 analysis represents research information, which should 22 be conducted on a periodic basis to anticipate any 23 mineral contamination in future assessments of other 24 exposures of talc in the district." 25 Q. Let me ask you to put that aside, please,</p>
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<p>1 referenced earlier, and I'll ask you to turn to page 28. 2 If you'll turn -- 3 A. I am on page 28. 4 Q. Right. And does page 28 relate to the 5 Hammondsville talc mine? 6 A. Yes, it does. 7 Q. And was the Hammondsville talc mine one 8 of the mines that was used to source Johnson & Johnson's 9 talc? 10 A. Yes. 11 Q. And if you'll look on the right-hand 12 side, on the second paragraph, do you see that? 13 A. Yeah. "The deposit consists entirely of 14 coarse, flakey grit and of steatite. No serpentinite 15 has been found. In the southwestern face of the quarry, 16 there is a large mass of actinolite rock." 17 Q. Does that support your opinions in this 18 case? 19 A. Yes. 20 MR. FROST: Objection. Form. 21 BY MS. O'DELL: 22 Q. Let me ask you to set that aside and turn 23 to Exhibit 18. It's the document, the "Preliminary 24 Investigation of Cosmetic Talc Potential" in China, 25 Kwangsi, China. I think you had it in front of you.</p>	<p>1 sir. Thank you. 2 If you'll turn now to the IARC monograph, 3 which I think is on the '93 monograph, which is right 4 there. Yes. 5 A. This? Five? 6 Q. That's right, Exhibit 5. 7 A. Okay. 8 Q. You were asked a number of questions 9 about a statement that you made in your report about, I 10 think along the lines of it was common to find minerals 11 such as tremolite, anthophyllite, asbestos in talc 12 deposits. Do you recall those lines of questions? 13 A. Yes. 14 Q. And if you'll turn to page 284 of the 15 IARC monograph, 284, and this is the '93 monograph that 16 relates to talc not containing asbestiform fibers. If 17 you look at the bottom of 284, what does it say in the 18 IARC monograph regarding the presence of these minerals 19 in talc deposits? 20 A. It discusses minerals associated with 21 talc. "The most common minerals found in talc products 22 include chlorite, magnesite, dolomite, tremolite 23 anthophyllite, serpentine and quartz." 24 Q. And if you'll turn over to page 285, that 25 statement is further supported in Table 1.4?</p>

<p style="text-align: right;">Page 322</p> <p>1 A. Yes.</p> <p>2 MR. FROST: Object to form.</p> <p>3 A. Tremolite is listed, anthophyllite is</p> <p>4 listed, actinolite is listed.</p> <p>5 BY MS. O'DELL:</p> <p>6 Q. And is that supportive of your opinion</p> <p>7 that those asbestos minerals are common in talc</p> <p>8 deposits?</p> <p>9 A. Yes.</p> <p>10 MR. FROST: Objection to form.</p> <p>11 BY MS. O'DELL:</p> <p>12 Q. Let me ask you just a general question</p> <p>13 first. How would you define fibrous talc?</p> <p>14 A. Fibrous talc is a talc particle that has</p> <p>15 a morphology consistent with the definition of a fiber.</p> <p>16 Q. And would it be fair to say that fibrous</p> <p>17 talc could be defined as talc formed in an asbestiform</p> <p>18 habit?</p> <p>19 MR. BILLINGS-KANG: Objection to form.</p> <p>20 MR. FROST: Objection to form.</p> <p>21 A. Yes.</p> <p>22 BY MS. O'DELL:</p> <p>23 Q. Let me ask you to look at Exhibit 22,</p> <p>24 Dr. Krekeler, which I think I had in front of you. It</p> <p>25 may be.</p>	<p style="text-align: right;">Page 324</p> <p>1 BY MS. O'DELL:</p> <p>2 Q. Dr. Krekeler, describe for us the</p> <p>3 methodology that you've used in reaching your opinions</p> <p>4 in this case.</p> <p>5 A. I evaluated data, I evaluated x-ray</p> <p>6 diffraction data, I evaluated core data, I evaluated</p> <p>7 electron microscopy data, I evaluated bulk chemistry</p> <p>8 data, I evaluated descriptions, I used peer-review</p> <p>9 literature, and these are essentially methods that would</p> <p>10 be expected if I was working as a consultant in a</p> <p>11 company.</p> <p>12 Q. Did you rely on published books regarding</p> <p>13 the geology of Vermont, Italy and China?</p> <p>14 A. Yes.</p> <p>15 Q. To the degree they were available?</p> <p>16 A. To the degree, yes. I would agree with</p> <p>17 that.</p> <p>18 Q. Is another common source that geologists</p> <p>19 rely on publications such as the U.S. Geological Survey?</p> <p>20 A. Yes.</p> <p>21 Q. And are there also publications from the</p> <p>22 U.S. Bureau of Mines?</p> <p>23 A. Yes.</p> <p>24 Q. And did you rely on those types of</p> <p>25 materials in reaching your opinions in this case?</p>
<p style="text-align: right;">Page 323</p> <p>1 A. Twenty-two?</p> <p>2 Q. Yes.</p> <p>3 A. Okay.</p> <p>4 Q. And I would like for you -- you recall</p> <p>5 there was a number of documents that Mr. Frost showed</p> <p>6 you regarding six asbestos test results that were</p> <p>7 contained in the asbestos chart in your report beginning</p> <p>8 at page 14. Do you recall those questions?</p> <p>9 A. Yes.</p> <p>10 Q. And if I marked them correctly, Mr. Frost</p> <p>11 pointed out one, two, three, four, five, six test</p> <p>12 results that he took issue with. Do you recall that?</p> <p>13 A. Yes.</p> <p>14 Q. How many positive tests results, just</p> <p>15 estimate if you don't know --</p> <p>16 A. Approximately 125.</p> <p>17 Q. So let me -- and so let me ask you this</p> <p>18 question. Is there anything that you heard today that,</p> <p>19 in your mind, would call into question the veracity of</p> <p>20 the test results that, the other 125 test results that</p> <p>21 you reported in the chart, which begins in your report</p> <p>22 on page 14?</p> <p>23 MR. FROST: Objection to form.</p> <p>24 A. No.</p> <p>25</p>	<p style="text-align: right;">Page 325</p> <p>1 A. Yes.</p> <p>2 Q. Is the methodology that you used</p> <p>3 methodology that would be generally acceptable in the</p> <p>4 field of geology?</p> <p>5 A. Yes.</p> <p>6 MR. FROST: Objection to form.</p> <p>7 BY MS. O'DELL:</p> <p>8 Q. Did you rely on peer-reviewed literature</p> <p>9 to support your opinions?</p> <p>10 A. Yes.</p> <p>11 Q. Is peer-reviewed literature always</p> <p>12 available for specific mineral formations or deposits in</p> <p>13 geology?</p> <p>14 A. Not necessarily.</p> <p>15 Q. You were asked about the documents that</p> <p>16 you had received, internal documents that you had</p> <p>17 received in formulating your opinions in this case.</p> <p>18 Obviously, corporate documents were not available to you</p> <p>19 other than lawyers giving them to you, fair?</p> <p>20 A. Yes. Correct.</p> <p>21 Q. You didn't have an independent way to get</p> <p>22 the documents from Johnson & Johnson or Imerys in order</p> <p>23 to reach your opinions, right?</p> <p>24 A. Correct.</p> <p>25 Q. And did you feel that you had adequate</p>

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<p>1 materials to support the opinions contained in your</p> <p>2 report?</p> <p>3 MR. FROST: Objection to form.</p> <p>4 MR. BILLINGS-KANG: Objection to form.</p> <p>5 A. Yes.</p> <p>6 BY MS. O'DELL:</p> <p>7 Q. In terms of the testing documents that</p> <p>8 are mentioned and reported in your expert report, are</p> <p>9 testing documents something that you rely on in the</p> <p>10 normal course of your role as a geologist?</p> <p>11 A. Yes.</p> <p>12 Q. Would that also be true of core logs?</p> <p>13 A. Yes.</p> <p>14 Q. And those are some of the documents that</p> <p>15 you cited in your report?</p> <p>16 A. Yes.</p> <p>17 Q. Let me ask you just to talk just briefly</p> <p>18 about your qualifications as a geologist. As a</p> <p>19 geologist, are you -- do you teach the process of</p> <p>20 evaluating mineral deposits?</p> <p>21 A. Yes. I teach a course on ore deposits,</p> <p>22 and I've taught courses on industrial mineralogy and</p> <p>23 I've taught --</p> <p>24 Q. Excuse me.</p> <p>25 A. When I was at George Mason, I would</p>	<p>1 particular order, but if we can first turn to the IARC</p> <p>2 monograph. It's the one right in front of you there.</p> <p>3 Which exhibit number is that?</p> <p>4 A. I'm sorry. What?</p> <p>5 Q. Which exhibit number is that?</p> <p>6 A. Five.</p> <p>7 Q. Okay. If you can turn to page 284.</p> <p>8 A. Okay.</p> <p>9 Q. So if you look at the bottom of the page,</p> <p>10 Miss O'Dell had you read from the line starting, "The</p> <p>11 most common minerals found in talc products," but before</p> <p>12 that, it reads, "Because talc deposits are formed from</p> <p>13 different protoliths under many different geological</p> <p>14 conditions, each talc deposit has a combination of</p> <p>15 mineralogy and mineral habit that is distinctive and, in</p> <p>16 many cases, unique." Did I read that correctly?</p> <p>17 A. There's no citation for that and, yes,</p> <p>18 you did.</p> <p>19 Q. Sir, my question is: Did I read that</p> <p>20 correctly?</p> <p>21 A. Yes.</p> <p>22 Q. And that's what the IARC monograph says,</p> <p>23 correct?</p> <p>24 A. Correct.</p> <p>25 Q. If you can turn to the Van Gosen article,</p>
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<p>1 regularly teach mineralogy.</p> <p>2 Q. And would those courses have included</p> <p>3 teaching students how to conduct expiration such as</p> <p>4 drilling, core drilling and other ways to define an ore</p> <p>5 deposit?</p> <p>6 A. Yes.</p> <p>7 MR. FROST: Object to form.</p> <p>8 BY MS. O'DELL:</p> <p>9 Q. Have you given presentations on those</p> <p>10 types of activities?</p> <p>11 A. Yes.</p> <p>12 MS. O'DELL: Okay. I don't have anything</p> <p>13 further. Thank you.</p> <p>14 THE WITNESS: Okay.</p> <p>15 MR. FROST: Could we go off the record?</p> <p>16 VIDEOGRAPHER: Sure. We are now going</p> <p>17 off record, and the time is 8:13.</p> <p>18 (A recess was taken from 8:13 to 8:20.)</p> <p>19 VIDEOGRAPHER: We are now back on record,</p> <p>20 and the time is 8:20.</p> <p>21 FURTHER CROSS-EXAMINATION</p> <p>22 BY MR. FROST:</p> <p>23 Q. All right, Doctor. A couple quick</p> <p>24 follow-ups, and unfortunately, I'm going to run them in</p> <p>25 the order they're in my binder, which probably is no</p>	<p>1 which is Exhibit 11.</p> <p>2 A. Okay.</p> <p>3 Q. Page 934.</p> <p>4 A. All right. I'm on that page.</p> <p>5 Q. Before, when you were reading this, you</p> <p>6 skipped over most of Number 3. Number 3 reads, "a</p> <p>7 nearly mono-mineralogical talc zone (often of high</p> <p>8 purity) several centimeters to meters thick." Did I</p> <p>9 read that correctly?</p> <p>10 A. Yes.</p> <p>11 Q. Do you agree with me that that would be</p> <p>12 the talc ore zone, correct?</p> <p>13 MS. O'DELL: Object to the form.</p> <p>14 A. Presumably. A nearly -- a nearly</p> <p>15 monomineralic -- mineralogical talc zone.</p> <p>16 BY MR. FROST:</p> <p>17 Q. Now, if we can turn to Exhibit 15, which</p> <p>18 is the Chidst article -- Chidester.</p> <p>19 A. 215.</p> <p>20 Q. And specifically page 28. Okay. Counsel</p> <p>21 had pointed you to the second paragraph, the second</p> <p>22 column down, and you read the, "In the southwest face of</p> <p>23 the quarry, there is large mass of actinolite rock,"</p> <p>24 correct?</p> <p>25 A. Correct.</p>

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1 Q. It doesn't say here that it's asbestos
2 actinolite, correct?
3 A. It does not specifically say that it's
4 asbestos.
5 Q. And you couldn't, without speculating,
6 based on this document, say whether or not it's
7 asbestos, correct?
8 MS. O'DELL: Object to the form.
9 A. I would agree.
10 BY MR. FROST:
11 Q. And then the sentence before that, the
12 end of it reads, No serpentine has been found; is that
13 correct?
14 A. No. It says, "No serpentinite."
15 Q. "No serpentinite," sorry, "has been
16 found"?
17 A. "Has been found."
18 Q. Okay. Sorry. I did read it incorrectly.
19 You are right. So "No serpentinite has been found"?
20 That's correct?
21 A. Correct.
22 MR. FROST: That's all questions I have,
23 sir.
24 VIDEOGRAPHER: Is that it?
25 MR. FERGUSON: I don't have any

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1 questions.
2 MS. O'DELL: I have nothing further.
3 MR. FROST: All right.
4 VIDEOGRAPHER: This adjourns the
5 deposition of Dr. Mark Krekeler. We are now
6 going off record, and the time is 8:24.
7 COURT REPORTER: What about signature?
8 MS. O'DELL: Yes.
9 (Exhibit 28 through 30 were marked for
10 identification.)
11 - - -
12 DEPOSITION CONCLUDED AT 8:34 P.M.
13 - - -
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1 CERTIFICATE
2 State of Ohio :
3 : SS
4 County of Hamilton :
5 I, Susan M. Gee, RMR, CRR, the undersigned, a
6 duly commissioned notary public within and for the State
7 of Ohio, do hereby certify that before the giving of his
8 aforesaid deposition, MARK KREKELER, Ph.D., was by me
9 first duly sworn to depose the truth, the whole truth
10 and nothing but the truth; that the foregoing is the
11 deposition given at said time and place by MARK
12 KREKELER, Ph.D.; that said deposition was taken in all
13 respects pursuant to stipulations of counsel; that I am
14 neither a relative of nor employee of any of their
15 parties or their counsel, and have no interest whatever
16 in the result of the action; that I am not, nor is the
17 court reporting firm with which I am affiliated, under a
18 contract as defined in Civil Rule 28(D).
19 IN WITNESS WHEREOF, I have hereunto set my
20 hand and official seal of office at Cincinnati, Ohio, on
21 this 29th day of January, 2019.
22
23 _____
24 My commission expires: S/ Susan M. Gee, RMR, CRR
25 September 20, 2020. Notary Public - State of Ohio

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3 DECLARATION UNDER PENALTY OF PERJURY
4
5 Case Name: Talcum Powder Litigation
6 Name of Witness: Mark Krekeler, Ph.D.
7 Date of Deposition: January 25, 2019
8
9 I, MARK KREKELER, Ph.D., hereby certify under
10 penalty of perjury under the laws of the State of
11 _____ that the foregoing is true and correct.
12 Executed this _____ day of
13 _____, 2019, at _____.
14
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17 _____
18 MARK KREKELER, Ph.D.
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1 DEPOSITION ERRATA SHEET
2 Case Name: Talcum Powder Litigation
Name of Witness: Mark Krekeler, Ph.D.
3 Date of Deposition: January 25, 2019
Reason Codes: 1. To clarify the record.
4 2. To conform to the facts.
3. To correct transcription errors.
5
6 Page _____ Line _____ Reason _____
7 From _____ to _____
8 Page _____ Line _____ Reason _____
9 From _____ to _____
10 Page _____ Line _____ Reason _____
11 From _____ to _____
12 Page _____ Line _____ Reason _____
13 From _____ to _____
14 Page _____ Line _____ Reason _____
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16 Page _____ Line _____ Reason _____
17 From _____ to _____
18 Page _____ Line _____ Reason _____
19 From _____ to _____
20 _____ Subject to the above changes, I certify that
the transcript is true and correct.
21 _____ No changes have been made. I certify that the
transcript is true and correct.
22
23 _____
24 MARK KREKELER, Ph.D.
25